

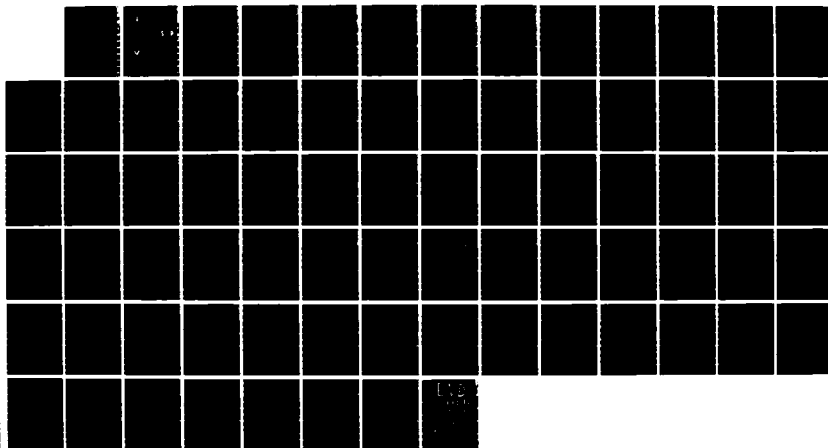
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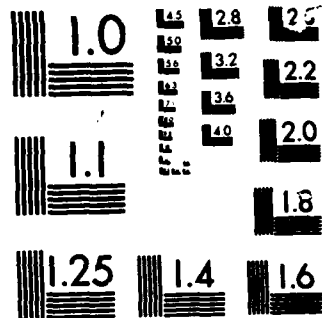
PCFIT - PLOTTING FITTING INTERPOLATING UTILITY PROGRAM
FOR IBM PC (PERSON.. (U) ARMY MISSILE COMMAND REDSTONE
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TECHNICAL REPORT RH-85-2

DRAFT IV - PCFIT
PLOTING, FITTING, INTERPOLATING UTILITY
PROGRAM FOR IBM PC

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JULY 1985

**U.S. ARMY MISSILE COMMAND***Redstone Arsenal, Alabama* 35898-5000

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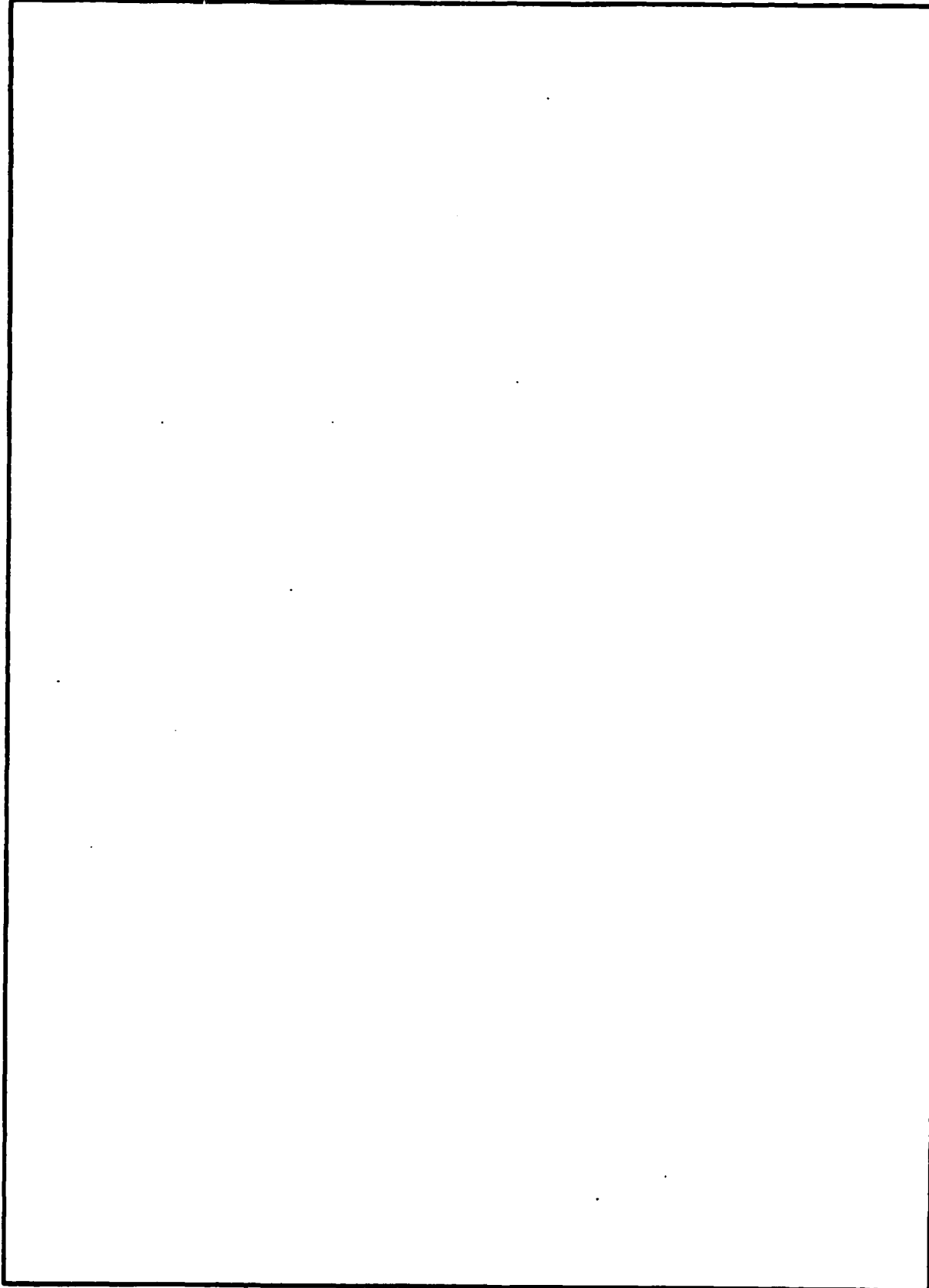
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I. INTRODUCTION

The personal computer is rapidly finding its place in both the business and scientific/engineering workplace. Desk top models available today surpass the computing power of the largest mainframe of a few years ago. A limit to the utility of these machines is the availability of useful utility routines that perform the functions routinely found on the more conventional computer hardware. The commercial market has reacted well to the demand of the business community and has provided a variety of available business oriented software. However, for the scientific/engineering community, notable gaps exist in the available software. To attempt to fill a void that exists at MICOM and suspected to exist elsewhere, the PCFIT series of computer programs was developed for routine plotting, fitting and interplotting of typical data encountered in the scientific/engineering community.

The PCFIT series of programs is a three member set of user friendly, menu driven programs with the capability of analyzing data in terms of eleven common functions. Table I lists the functions currently available. This series of programs differs primarily in the hardware requirements to implement and the form of the resulting graphical output. Each of the programs has the same mathematical basis and identical analysis capabilities. Table II lists the hardware requirements for each of these programs. In as much as possible each program has the same form and relatively the same input format. PCFITM, the simplest of the programs, has very simple "line printer" graphics output and consequently limited options. PCFITG with stronger graphics capabilities allows the user to select a variety of formats with which to display the graphical output. PCFITP which requires the availability of a Hewlett-Packard plotter allows the greatest variety in the graphics, in format, color and the actual number of curves that can be plotted on a single graph. The graphics range from crude to adequate but no attempt has been made to provide "professional graphics" in any case. An option is provided to allow curves once generated to be stored in data files for future import to professional plotting programs or other analysis programs.

TABLE 1. PCFIT Available Functions

$$Y = A + BX$$

$$Y = A \exp(BX)$$

$$Y = AX^B$$

$$Y = A + B/X$$

$$Y = 1/(A + BX)$$

$$Y = X/(A + BX)$$

$$Y = \text{POLYNOMIAL}$$

$$Y = \text{LAGRANGE INTERPOLATION}$$

$$Y = \text{SPLINE FIT}$$

$$Y = \text{FOURIER SERIES}$$

$$Y = \text{NATURAL CUBIC SPLINE}$$

TABLE 2. Hardware Requirements

PCFITM	192K MEMORY
	MONOCHROME BOARD
	MONOCHROME MONITOR
	PRINTER(FOR HARDCOPY)
PCFITG	256K MEMORY
	GRAPHICS BOARD
	GRAPHICS MONITOR
	GRAPHICS PRINTER(FOR HARDCOPY)
	GRAPHMATICS(MICROCOMPATIBLES)
PCFITP	256K MEMORY
	HEWLETT-PACKARD PLOTTER
	PRINTER(FOR HARDCOPY)
	PLOTMATIC(MICROCOMPATIBLES)

FORMAT FOR DATA FILES:

The data input to the PCFIT is from data files with the following form:

<u>Line</u>	<u>CONTENT</u>
1	TITLE (up to 50 characters)
2	X-AXIS LABEL (up to 50 characters)
3	Y-AXIS LABEL (up to 50 characters)
4	X(1),Y(1) - 1st directed format
.	.
.	.
.	.
.	.
N	X(N),Y(N) (up to 200 data pairs)

NOTE: It is recommended that the labels used for the axes be limited to approximately ten characters.

THE COEFFICIENT OF DETERMINATION, RSQ:

The only statistical information involved in the PCFIT series of programs is the coefficient of determination. The program is only intended to give a quick visual look at the abilities of the various options, not a comprehensive statistical "look" at those abilities.

RSQ is given by the following equation:

$$RSQ = 1. - \frac{SSE}{\sum_{i=1}^N (Y_i - \bar{Y})^2}$$

where (x_i, y_i) are a set of N data points

\bar{y} - arithmetic average of the y_i values

SSE - sum of squares for error

$$SSE = \sum_{i=1}^N (y_i - y_{\text{calculated at } x_i})^2$$

If the curve passes through all points, then

$$RSQ = 1.00$$

If the curve misses the data points by large deviations and the data is quite scattered the RSQ will be small. Thus, RSQ for some options gives an indication of which curves fit the data points "best." Caution - Even if RSQ = 1., the curve may behave wildly between data points and/or outside the given data range.

AVAILABLE OPTIONS:

Table I summarizes the options available in the PCFIT series of programs. Options 1 through 8 are common functions and will not be discussed further.

The Spline Fit, Option 9, uses knots, juncture points at which the polynomials' derivatives are matched, selected automatically by the routine to be such that the data set is divided into up to five equal subsets. Each subset must contain at least seven data points. Third degree polynomials are calculated and plotted in each spline segment, with the first and second derivatives being matched at the common points. The Y array can be multiple valued. The X array must be in ascending order for correct assignment of points to the spline segments. Reordering is performed by the program, routine XREOD, if necessary.

The Fourier Series Representation, Option 10 - any single-valued function that is continuous, except possibly for a finite number of discontinuities in the interval of length 2L, and which has a finite number of maxima and minima in this interval, may be represented by a convergent Fourier series of the form:

$$Y = 0.5A_0 + \sum_{n=1}^{\infty} (A_n \cos(n\pi x/L) + B_n \sin(n\pi x/L))$$

The program essentially forms such a single-valued function from the (X,Y) data by joining the points with straight lines. The user selects the number of terms to be used in the finite series approximation of the above equation. The program uses a numerical integration technique to calculate the coefficients A_n and B_n . The resultant curve is then superimposed on the data points and Fourier coefficients displayed. A maximum of 10 values of A_n and B_n are displayed. The parameter L in the above equation is given by

$$L = 0.5(X(\text{data upper limit}) - X(\text{data lower limit})).$$

The more points used, the better, due to the method of forming the single valued function.

Natural Cubic Spline Interpolation, Option 12 - during the past decade spline functions have gained widespread use in numerical analysis. Briefly, splines are piece-wise polynomials with continuity in derivatives through

one less than the polynomial order, and with the juncture points between different polynomials (knots), usually at the data points. End conditions can be prescribed on the derivatives at these end points. The natural cubic spline employs third degree polynomials, knots at the data points, with second derivatives vanishing at the end data points.

The theory of splines is fairly involved and deals mainly with establishing various existence, uniqueness, and convergence properties. However, perhaps the most important practical results for data fitting establish splines as one of the best approximations, in various mathematical senses, to tabular data. Of particular importance is the result that for a given set of X-Y data in the interval (a,b), of all functions $f(x)$ with continuous second derivative and such that $f(x_i) = y_i$, the spline function with knots at data points and second derivatives equal to zero at and "a" "b" minimizes the integral

$$\int_a^b |f''(x)|^2 dx$$

Note that $f''(x)$ is often a good approximation to curvature.

Data Smoothing, Option 13 - this option performs the user's choice of first or third degree five point smoothing of the current Y array. Each Y value is replaced by the value given by a local least squares curve at the corresponding X. This curve is determined by using the original Y value plus the two original Y values on either side. For the end and next-to-end points, the choice is skewed so as to give a total of five points as close to the end as possible. Data points must be equally spaced in X. Therefore, caution must be shown in using this option.

First degree smoothing is commonly referred to as a moving average. It may be necessary to call the smoothing option several times in succession, smoothing the smoothed data, to yield values acceptable to the user. It is recommended that the grossly outlying data be corrected or removed before using least squares smoothing.

INPUT GUIDES FOR PCFIT PROGRAMS:

The following three sections contain detailed input guides for PCFITM, PCFITG, and PCFITP, respectively. Many of the sections are identical but have been included in a redundant fashion to facilitate the use of the user's choice of program. The reader is encouraged to review the appendix that contains sample runstreams for typical examples of the programs for further clarification.

TABLE 3. DATA1.DAT

TITLE
X-AXIS
Y-AXIS

1.0000	2.0000
1.2000	2.2000
1.4000	2.0000
1.6000	2.4000
1.8000	2.1000
2.0000	2.3000
2.2000	2.5000
2.4000	2.3000
2.6000	2.8000
2.8000	2.4000
3.0000	2.7000
3.2000	3.1000
3.4000	2.6000
3.6000	3.0000
3.8000	2.9000
4.0000	3.0000
4.2000	3.2000
4.4000	3.1000
4.6000	3.3000
4.8000	3.2000
5.0000	3.4000
5.2000	3.2000
5.4000	3.0000
5.6000	2.9000
5.8000	2.5000
6.0000	2.2000

II. PCFITH

PCFITH is the least demanding as far as hardware, but also is least impressive as to the graphical output provided. The minimum system must have 192K of memory, a monochrome board, and correspondingly, a monochrome monitor. The text-only nature of the monitor limits the detail of the graphical output.

INPUT GUIDE FOR PCFITH:

For PCFITH as well as the other members of the series the user inputs are menu driven prompts with an attempt made to make the selections somewhat self evident for the user. To run PCFITH the user is presented with five menus in order: (1) DATA INPUT MENU, (2) LOG MENU, (3) DATA SCALING MENU, (4) OPTION SELECTION MENU and (5) PLOTTING MENU. The program is designed such that the user may, having completed one calculation repeat any of the previous menu selection processes. Additionally, the program does not terminate naturally but allows the user to select alternate curve functions, plotting options, or scaling options without re-entering the data.

For the purposes of this report, a sample data set will be used and will be referred to as DATA1.DAT; Table III contains this data set for reference.

DATA INPUT MENU - STARTING THE PROGRAM:

The program is started by typing the command PCFITH following the system prompt. The program enters the "DATA INPUT MENU" initially and prompts the user as to whether printed output is desired.

PRINTED OUTPUT? (Y/N)

This simple option either provides or suppresses output to the printer. The characteristic slowness of typical printers associated with PC type computers may require excessive time as compared to the actual computational times involved, thus suppression of printed output may be desired.

The user is then prompted to enter the name of a file containing the data to be analyzed.

ENTER DATA FILE NAME

It is assumed that the data has previously been stored in a data file in the form described in the previous section of this report. The user enters the data file name, the program displays the data on the monitor as it is read and prints a listing if the printing option was selected.

Following this step the user is prompted as to whether additional data files are to be read thus allowing combining data from more than one file.

ADDITIONAL DATA FILES? (Y/N)

The answer is either "Y" or "N" depending on the situation. PCFITP will treat this option somewhat differently and will provide for plotting multiple curves on a single chart.

LOG MENU:

The second menu section is now entered allowing the user the option of performing the plotting, fitting or interpolations using the logarithm of X and/or logarithm of Y and, independent of this choice, plotting the results in normal, semi-log, or log-log form. The user is presented with a menu of the following form:

CALCULATE WITH LOGS? X Y XY N NN EX

X - LOG(X DATA)

Y - LOG(Y DATA)

XY - LOG(X DATA) AND LOG(Y DATA)

N - DO NOT USE LOGS - MAY USE LOGS IN PLOTTING OF DATA

NN - DO NOT USE LOGS AS INPUT OR PLOTTING OF DATA

EX - STOP

Selection of "X", "Y", or "XY" will cause the program to take the log(10) of appropriately X, Y, or X and Y before proceeding with the fitting or interpolation process. Upon completion of the program the data will be returned to the original state. Selection of "N" indicates the logarithm is not to be used in the calculations but allows a future menu selection concerning the plotting of the data. Selection of "NN" provides a presupposed response to the next prompt and provides an early answer that logarithms are not to be used in either the calculations or the plotting of the graphical output. The selection of "EX" terminates the program.

Providing the "NN" option was not selected, the user is prompted for the plotting relative to logarithms:

PLOT LOGS? X Y XY N NN EX

This prompt is analogous to the previous and allows selection of options associated with the plotted output.

DATA SCALING MENU:

The data scaling options menu allows the scaling of the data for plotting purposes. The form of this menu is:

SCALE DATA - ENTER S X Y O E N IN ANY ORDER

S - SCALE DATA	X - ORIGIN IS AT X=0
Y - ORIGIN IS AT Y=0	O - USER SPECIFIED ORIGIN
E - END(STOP)	N - NOTHING

Prior to plotting the data, it must be scaled to provide scaling parameters/factors to assure that all data will appear within the range of the graphical plot. The selection of the "S" option scales the data in a manner such that the range of the X and Y axes will contain all data. If the data is somewhat integer-like, data points may be located on the axes which may not provide an attractive output plot. To avoid this shortcoming of the scaling, additional scaling options are provided. The selection of "SX", "SY", or "SXY" will scale the data in a manner such that the origin is located at X=0, Y=0, or X=Y=0, respectively. This option, depending on the data, may then displace the curve from the origin. Care should be taken before using this option to assure the data can be represented adequately with its use. If negative numbers are involved the program will prompt the user to this fact and not allow the option to be used.

While the program selects reasonable numbers for labeling the tic marks on the axes, they may be manually adjusted to the satisfaction of the user by specifying the "S0" option. If the "S0" option is selected the program will calculate an initial set of scaling parameters and display them to the user in the form of a prompt:

ORIGIN AT X = .80000 STEPS OF .80000

ENTER NEW VALUES, OTHERWISE ENTER ,,

At this time the user may elect to use these scaling parameters, by specifying ",", or enter parameters of his choosing by specifying the value of X(or Y) at the origin and the value of the increment of X(or Y) associated with each major tic mark. It should be noted that the user must select these parameters so that all data is contained within the resulting plot. If the range of the axes is not adequate to contain the data, data points may "wrap around" and appear in strange locations or not appear in the graphical output. The program

will check the values thus entered to assure the range is appropriate to contain all data. If the range is found to be inadequate, the user will be prompted in the form:

SPECIFIED ORIGIN LARGER THAN SOME DATA POINTS - RE-ENTER

At this time the user should enter a new value for the origin. If the range is still found to be inadequate, the user is further prompted by :

STEP SIZE INSUFFICIENT FOR DATA - RE-ENTER

At which time the user can adjust the increments associated with each major tic mark.

OPTION SELECTION MENU:

Initially the program exercises the first six of the possible options automatically and provides as guidance to the user a measure of the "goodness" of the fit in terms of the coefficient of determination, RSQ, previously discussed. The following form of information is then provided the user with the prompt allowing the user to specify the option of his choice.

EQN#	FUNCTION	RSQ
1	$Y = A + BX$	.4163
2	$Y = A * E^{BX}$	.4224
3	$Y = A * X^{*B}$	.5390
4	$Y = A + B/X$	.5358
5	$Y = 1/(A+B*X)$	.4255
6	$Y = X/(A+B*X)$	.5911
7	POLYNOMIAL	
8	LAGRANGE INTERPOLATION	
9	SPLINE FIT	
10	FOURIER SERIES	
11	DATA ALONE	
12	NATURAL CUBIC SPLINE	
13	SMOOTHED DATA	

ENTER: # L SA ST DA RS RP EX

# - EQUATION NUMBER	L - LIST DATA
SA - SAVE CURVE ON FILE	ST - STOP
DA - READ NEW DATA SET	RS - RESTART
RP - REPLOT DATA	EX - EXIT(STOP)

At this point the user is to select the option, 1 - 13, desired or an alternative operation as indicated by the alphabetic codes.

The desired mathematical form of the function with which the data is to be analyzed is selected by the appropriate numerical value 1 - 13. For the first six options, the user is provided with some indication of the appropriateness of these function to represent the data; a high degree of "fit" is indicated by a RSQ value near unity. It is recommended that the form of the function be examined particularly for the more non-linear options 8-13 for a RSQ value near unity simply means the curve nearly passes through all data points. The behavior of the curve between data points or the slope of the curve at the data points may not represent the physics of the data.

Option 7, the polynomial, may be up to 14th order; if this option is selected the user will be prompted to select the desired order. If an order is selected that is not supported by the data, i.e. larger order than there are data points, the program will correct the choice of order to a more appropriate value.

Option 8 will prompt the user to select the appropriate number of data points to be used in the polynomial interpolating formula; usually between 2 and 4. Additionally, a brief help menu is provided for this option.

Option 9 will automatically divide the data range into three subranges for fitting by third degree polynomials in each subrange.

Option 10 will also prompt the user to select the appropriate number of series terms data points to be used.

Option 11 does not perform any analysis of the data but simply allows the user to plot the input values.

Option 13 provides two smoothing techniques, first and third degree, the user will be prompted to select one or the other; a brief help menu is also provided. Once the data is smoothed the program is re-entered at the scaling menu since the data should now be somewhat more confined in terms of the excursions along the Y axis. The data is then rescaled and subsequently plotted, fitted, interpolated, or smoothed as the user desires.

The selection of the "L" option will list on the screen the data being analyzed and return to the menu for further instructions.

The "SA" option allows the user to save the data that makes up the fitted or interpolated curve. This option can only be used if a curve has been generated -that is it cannot be used on the first pass through the program. Assuming one of the eleven fitting/interpolating options has been previously selected and the resulting curve found to be worthy of saving for future use, it may be saved in a separate file by specifying the "SA" option. If this option is selected the user will be prompted to specify a file name in which to store the data followed by a prompt as to whether the title and axes labels are to be stored also. Depending on the purpose of selecting this option, the answer may be either "Y" or "N". If, for example, the purpose of saving the data is

to allow import into a different program one may not want to save the title and labels, only the X and Y values. Alternatively, if the purpose of selection of this option is to use it as input data to PCFIT, the title and labels would be desired. The curves generated in any of the PCFIT programs consist of one hundred X-Y data pairs. Some programs or some situations may not allow this many data points to be used so options are provided to store 25, 50, or 100 data points. The user is prompted to enter his choice; the method used when either 50 or 25 data points is selected is to store in the file every other or every fourth data point.

The "ST" option simply terminates the program.

The selection of the "DA" option reschedules the program at the beginning allowing a new set of data to be entered. This option causes the program to discard the current data set and prompt the user for the file name of the file containing the new data to be analyzed. This option does not allow the new data to simply be appended to the end of the current data set.

The selection of the "RS" or restart option reschedules the program at the point of the LOG MENU. This option retains the data currently under analysis.

The "RP" or replot option reschedules the program at the point of the SCALING MENU to allow adjustments generally through the use of user specified origin option in this menu.

The "EX" option is an alternate to the "ST" option performing the same function of terminating the program.

Assuming one of the eleven function was selected as the form of the data analysis, the program calculates and displays on the monitor, and printer if not suppressed, the option selected, a measure of the quality of the fitted/interpolated curve, RSQ, and the appropriate coefficients. This information will be displayed in the form:

OPTION NO. 7

Y=POLYNOMIAL

DEGREE = 5

RSQ = .8893

C0 = .246761E+01

C1 = -.128385E+01

C2 = .125361E+01

C3 = -.470453E+00

C4 = .863621E-01

C5 = -.617910E-02

PLOTTING MENU:

PCFITM will automatically provide a "line printer" type display of the specified graphical output on the monitor. The resolution of the monitor is such that much of the detail is lost in the process. The user is prompted as to whether a hard copy is desired:

HARD COPY? (Y/N)

If the user specifies "Y" the resulting graph is expanded to fill a full sheet of paper adding some detail to the resulting chart.

The program returns to the OPTIONS MENU for specification of additional options.

MULTIPLE PLOTS:

Plotting of multiple curves using the low resolution plotting options provided in PCFITM is not recommended.

III. PCFITG

PCFITG provides adequate representation of the data and resulting fitted or interpolated curves on a graphical monitor. The minimum system must have 256K of memory, a color graphics or monochrome graphics board, and correspondingly, a graphics or monochrome monitor. Additionally, the program utilizes the GRAPHMATIC library routines available from MICROCOMPATIBLES that must be supplied by the user. The resolution of the monitor limits the detail of the graphical output.

INPUT GUIDE FOR PCFITG:

For PCFITG, as well as the other members of the series, the user inputs are menu driven prompts with an attempt made to make the selections somewhat self evident for the user. To run PCFITG the user is presented with five menus in order: (1) DATA INPUT MENU, (2) LOG MENU, (3) DATA SCALING MENU, (4) OPTION SELECTION MENU and (5) PLOTTING MENU. The program is designed such that the user may, having completed one calculation, repeat any of the previous menu selection processes. Additionally, the program does not terminate naturally but allows the user to select alternate curve functions, plotting options, or scaling options without re-entering the data.

For the purposes of this report, a sample data set will be used and will be referred to as DATA1.DAT; Table III contains this data set for reference.

DATA INPUT MENU - STARTING THE PROGRAM:

The program is started by typing the command PCFITG following the system prompt. The program enters the "DATA INPUT MENU" initially and prompts the user as to whether printed output is desired.

PRINTED OUTPUT? (Y/N)

This simple option either provides or suppresses output to the printer. The characteristic slowness of typical printers associated with PC type computers may require excessive time as compared to the actual computational times involved, thus suppression of printed output may be desired.

The user is then prompted to enter the name of a file containing the data to be analyzed.

ENTER DATA FILE NAME

It is assumed that the data has previously been stored in a data file in the form described in the previous section of this report. The user enters the

data file name, the program displays the data on the monitor as it is read and prints a listing if the printing option was selected.

Following this step the user is prompted as to whether additional data files are to be read thus allowing combining data from more than one file.

ADDITIONAL DATA FILES? (Y/N)

The answer is either "Y" or "N" depending on the situation. PCFITP will treat this option somewhat differently and will provide for plotting multiple curves on a single chart.

LOG MENU:

The second menu section is now entered allowing the user the option of performing the plotting, fitting or interpolations using the logarithm of X and/or logarithm of Y and, independent of this choice, plotting the results in normal, semi-log or log-log form. The user is presented with a menu of the following form:

CALCULATE WITH LOGS? X Y XY N NN EX

X - LOG(X DATA)

Y - LOG(Y DATA)

XY - LOG(X DATA) AND LOG(Y DATA)

N - DO NOT USE LOGS - MAY USE LOGS IN PLOTTING OF DATA

NN - DO NOT USE LOGS AS INPUT OR PLOTTING OF DATA

EX - STOP

Selection of "X", "Y", or "XY" will cause the program to take the log (10) of appropriately X, Y, or X and Y before proceeding with the fitting or interpolation process. Upon completion of the program the data will be returned to the original state. Selection of "N" indicates the logarithm is not to be used in the calculations but allows a future menu selection concerning the plotting of the data. Selection of "NN" provides a presupposed response to the next prompt and provides an early answer that logarithms are not to be used in either the calculations or the plotting of the graphical output. The selection of "EX" terminates the program.

Providing the "NN" option was not selected the user is prompted for the plotting relative to logarithms:

PLOT LOGS? X Y XY N NN EX

This is analogous to the previous and allows selection of options associated with the plotted output.

DATA SCALING MENU:

The data scaling options menu allows the scaling of the data for plotting purposes. The form of this menu is:

SCALE DATA - ENTER S X Y O E N IN ANY ORDER

S - SCALE DATA	X - ORIGIN IS AT X=0
Y - ORIGIN IS AT Y=0	O - USER SPECIFIED ORIGIN
E - END(STOP)	N - NOTHING

Prior to plotting the data it must be scaled to provide scaling parameters/factors to assure that all data will appear within the range of the graphical plot. The selection of the "S" option scales the data in a manner such that the range of the X and Y axes will contain all data. If the data is somewhat integer-like, data points may be located on the axes which may not provide an attractive output plot. To avoid this shortcoming of the scaling, additional scaling options are provided. The selection of "SX", "SY", or "SXY" will scale the data in a manner such that the origin is located at X=0, Y=0 or X=Y=0, respectively. This option, depending on the data, may then displace the curve from the origin. Care should be taken before using this option to assure the data can be represented adequately with its use. If negative numbers are involved, the program will prompt the user to this fact and not allow the option to be used.

While the program selects reasonable numbers for labeling the tic marks on the axes, they may be manually adjusted to the satisfaction of the user by specifying the "S0" option. If the "S0" option is selected the program will calculate an initial set of scaling parameters and display them to the user in the form of a prompt:

ORIGIN AT X = .80000 STEPS OF .80000
ENTER NEW VALUES, OTHERWISE ENTER ,,

At this time the user may elect to use these scaling parameters by entering ".,", or entering parameters of his choosing by specifying the value of X (or Y) at the origin and the value of the increment of X (or Y) associated

with each major tic mark. It should be noted that the user must select these parameters such that all data is contained within the resulting plot. The graphical output is such that there are eight (8) divisions along the X axis and five (5) along the Y axis. If the range of the axes is not adequate to contain the data, data points may "wrap around" and appear in strange locations or not appear in the graphical output. The program will check the values thus entered to assure the range is appropriate to contain all data. If the range is found to be inadequate, the user will be prompted in the form:

SPECIFIED ORIGIN LARGER THAN SOME DATA POINTS - RE-ENTER

At this time the user should enter a new value for the origin. If the range is still found to be inadequate, the user is further prompted by:

STEP SIZE INSUFFICIENT FOR DATA - RE-ENTER

at which time the user can adjust the increments associated with each major tic mark.

OPTION SELECTION MENU:

Initially, the program exercises the first six of the possible options automatically and provides, as guidance to the user, a measure of the "goodness" of the fit in terms of the coefficient of determination, RSQ, previously discussed. The following form of information is then provided the user with the prompt allowing the user to specify the option of his choice.

EQN#	FUNCTION	RSQ
1	$Y = A + BX$	.4163
2	$Y = A * E^{BX}$	.4224
3	$Y = A * X^B$	.5390
4	$Y = A + B/X$	.5358
5	$Y = 1/(A+B*X)$	.4255
6	$Y = X/(A+B*X)$	.5911
7	POLYNOMIAL	
8	LAGRANGE INTERPOLATION	
9	SPLINE FIT	
10	FOURIER SERIES	
11	DATA ALONE	
12	NATURAL CUBIC SPLINE	
13	SMOOTHED DATA	

ENTER: # L SA ST DA RS RP EX

# - EQUATION NUMBER	L - LIST DATA
SA - SAVE CURVE ON FILE	ST - STOP
DA - READ NEW DATA SET	RS - RESTART
RP - REPLOT DATA	EX - EXIT(STOP)

At this point the user is to select the option, 1 - 13, desired or an alternative operation as indicated by the alphabetic codes.

The desired mathematical form of the function with which the data is to be analyzed is selected by the appropriate numerical value 1 - 13. For the first six options the user is provided with some indication of the appropriateness of these function to represent the data; a high degree of "fit" is indicated by a RSQ value near unity. It is recommended that the form of the function be examined particularly for the more non-linear options 8-13 for a RSQ value near unity simply means the curve nearly passes through all data points. The behavior of the curve between data points or the slope of the curve at the data points may not represent the physics of the data.

Option 7, the polynomial, may be up to 14th order; if this option is selected the user will be prompted to select the desired order. If an order is selected that is not supported by the data, i.e. larger order than there are data points, the program will correct the choice of order to a more appropriate value.

Option 8 will prompt the user to select the appropriate number of data points to be used in the polynomial interpolating formula; usually between 2 and 4. Additionally, a brief help menu is provided for this option.

Option 9 will automatically divide the data range into three subranges for fitting by third degree polynomials in each subrange.

Option 10 will also prompt the user to select the appropriate number of series terms to be used.

Option 11 does not perform any analysis of the data but simply allows the user to plot the input values.

Option 13 provides two smoothing techniques, first and third degree, the user will be prompted to select one or the other; a brief help menu is also provided. Once the data is smoothed, the program is re-entered at the scaling menu since the data should now be somewhat more confined in terms of the excursions along the Y axis. The data is then rescaled and subsequently plotted, fitted, interpolated, or smoothed as the user desires.

The selection of the "L" option will list on the screen the data being analyzed and return to the menu for further instructions.

The "SA" option allows the user to save the data that makes up the fitted or interpolated curve. This option can only be used if a curve has been generated -that is, it cannot be used on the first pass through the program. Assuming one of the eleven fitting/interpolating options has been previously selected and the resulting curve found to be worthy of saving for future use, it may be saved in a separate file by specifying the "SA" option. If this option is selected, the user will be prompted to specify a file name in which to store the data followed by a prompt as to whether the title and axes labels are to be stored also. Depending on the purpose of selecting this option, the answer may be either "Y" or "N". If, for example, the purpose of saving

the data is to allow import into a different program one would not want to save the title and labels, only the X and Y values. Alternatively, if the purpose of selection of this option is to use it as input data to PCFIT, the title and labels would be desired. The curves generated in any of the PCFIT programs consist of one hundred X-Y data pairs. Some programs or some situations may not allow this many data points to be used so options are provided to store 25, 50, or 100 data points. The user is prompted to enter his choice; the method used when either 50 or 25 data points is selected is to store in the file every other or every fourth data point.

The "ST" option simply terminates the program.

The selection of the "DA" option reschedules the program at the beginning allowing a new set of data to be entered. This option causes the program to discard the current data set and prompt the user for the file name of the file containing the new data to be analyzed. This option does not allow the new data to simply be appended to the end of the current data set.

The selection of the "RS" or restart option reschedules the program at the point of the LOG MENU. This option retains the data currently under analysis.

The "RP" or replot option reschedules the program at the point of the SCALING MENU to allow adjustments generally through the use of user specified origin option in this menu.

The "EX" option is an alternate to the "ST" option performing the same function of terminating the program.

Assuming one of the eleven function's was selected as the form of the data analysis, the program calculates and displays on the monitor, and printer if not suppressed, the option selected, a measure of the quality of the fitted/interpolated curve, RSQ, and the appropriate coefficients. This information will be displayed in the form:

OPTION NO. 7

Y=POLYNOMIAL

DEGREE = 5

RSQ = .8893

C0 = .246761E+01

C1 = -.128385E+01

C2 = .125361E+01

C3 = -.470453E+00

C4 = .863621E-01

C5 = -.617910E-02

PLOTTING MENU:

Following the display of the coefficients the user is presented with the PLOTTING MENU. This menu is for the selection of options associated with the plotting and display of the data points only. The fitted curve is always in the form of one hundred data points that in general are closely spaced to appear as a continuous curve. The plotting option menu has the form:

**** PLOTTING OPTIONS ****

ENTER: P A L B D + X * . O H M N E

P - PLOT DATA AS + SYMBOLS	A - PLOT AXES
L - COMMENT DATA POINTS	B - BROKEN LINE
D - USE DIAMOND	+ - USE +
X - USE X	* - USE *
. - USE .	O - USE O
H - HIGH RESOLUTION(DEF)	M - MEDIUM RES
N - NOTHING	E - END(STOP)

The user may enter up to ten of the letters in a string to specify the selection of options; however, there are not, in general, ten options to be selected at any one time.

In order that the input data is plotted, the "P" option must be selected. This option will then plot each data point as a "+" symbol.

The selection of the "A" or axis option includes the axes and axes labels and graph title in the graphical output.

The "L" option connects the data points by solid lines, the "B" option connects the data points by broken or dotted lines. These options may be used either independently of or in conjunction with the "P" option. If the combination "PL" or "PB" is used the data points, "+" symbols, are connected by solid or broken lines. If only "L" or "B" option selected, no symbols will appear on the graph.

The "D", "+", "X", "*", ".", and "O" options must be used in conjunction with the "P" option and specify alternate symbols to be used to represent the data points. The "D" option represents a diamond, ASCII symbol 004, "+" option is a plus sign somewhat larger than the default plus symbol, "X" option is the symbol X, "*" is the symbol *, "." option is a period -recommended if there is a large amount of data and "O" is the symbol O. These options can

also be used in conjunction with either option "L" or "B" to connect data point symbols with either solid or broken lines.

The "H" and "M" options specify the resolution of the graphical display. The default value is "H" and is 640 x 200 resolution in black and white. The medium resolution, "M" option, is 320 x 200 resolution with color if a color monitor is used.

The "N" option returns the program to the previous menu and the "E" option terminates the program.

Once the graphical display has been formed on the monitor the user is then prompted as to whether a hard copy of the plot is desired.

HARD COPY (Y/N)

Providing the user has a dot matrix printer with graphics capability, the screen can be "dumped" to the printer by specifying "Y".

The program now returns to the OPTIONS MENU for selection of alternate functions or other options available to the user. This process may be repeated indefinitely at the discretion of the user.

MULTIPLE CURVES:

This program provides for only simple options for plotting more than one curve on a single chart. This option will only allow plotting of two or three curves on a single chart by (1) analyzing data set number 1 and saving the preferred curve by specification of "SA" in the OPTIONS MENU, (2) repeat the process for the remaining data sets, (3) re-run PCFITG using the "saved curves" as input and combining into a single data set, and finally (4) plotting the data as individual data points. Since each of these data sets may contain up to 100 data points, the plotted result will appear as a near continuous line on the monitor for each of the data sets. PCFITP provides much more impressive graphical output and options for plotting multiple curves on a single chart.

IV. PCFITP

PCFITP provides adequate representation of the data and resulting fitted or interpolated curves on a Hewlett-Packard plotter. The minimum system must have 256K of memory. Additionally, the program utilizes the PLOTMATIC library routines that must be supplied by the user. The resolution of the plotter limits the detail of the graphical output.

INPUT GUIDE FOR PCFITP:

For PCFITP as well as the other members of the series, the user inputs are menu driven prompts with an attempt made to make the selections somewhat self evident for the user. To run PCFITP the user is presented with five menus in order: (1) DATA INPUT MENU, (2) LOG MENU, (3) DATA SCALING MENU, (4) OPTION SELECTION MENU and, (5) PLOTTING MENU. The program is designed such that the user may, having completed one calculation, repeat any of the previous menu selection processes. Additionally, the program does not terminate naturally but allows the user to select alternate curve functions, plotting options or scaling options without re-entering the data.

For the purposes of this report, a sample data set will be used and will be referred to as DATA1.DAT; Table III contains this data set for reference.

DATA INPUT MENU - STARTING THE PROGRAM:

The program is started by typing the command PCFITP following the system prompt. The program enters the "DATA INPUT MENU" initially and prompts the user as to whether printed output is desired.

PRINTED OUTPUT? (Y/N)

This simple option either provides or suppresses output to the printer. The characteristic slowness of typical printers associated with PC type computers may require excessive time as compared to the actual computational times involved, thus suppression of printed output may be desired.

The user is then prompted to enter the name of a file containing the data to be analyzed.

ENTER DATA FILE NAME

It is assumed that the data has previously been stored in a data file in the form described in the previous section of this report. The user enters the data file name, the program displays the data on the monitor as it is read, and prints a listing if the printing option was selected.

Following this step, the user is prompted as to whether additional data files are to be read thus allowing data from more than one file to be combined.

ADDITIONAL DATA FILES? (Y/N)

The answer is either "Y" or "N" depending on the situation. PCFITP treats this option somewhat differently and will provide for plotting multiple curves on a single chart. Plotting of multiple curves will be discussed at the conclusion of this chapter.

LOG MENU:

The second menu section is now entered allowing the user the option of performing the plotting, fitting, or interpolations using the logarithm of X and/or logarithm of Y and independent of this choice, plotting the results in normal, semi-log, or log-log form. The user is presented with a menu of the following form:

CALCULATE WITH LOGS? X Y XY N NN EX

X - LOG(X DATA)

Y - LOG(Y DATA)

XY - LOG(X DATA) AND LOG(Y DATA)

N - DO NOT USE LOGS - MAY USE LOGS IN PLOTTING OF DATA

NN - DO NOT USE LOGS AS INPUT OR PLOTTING OF DATA

EX - STOP

Selection of "X", "Y" or "XY" will cause the program to take the log (10) of appropriately X, Y, or X and Y before proceeding with the fitting or interpolation process. Upon completion of the program, the data will be returned to the original state. Selection of "N" indicates the logarithm is not to be used in the calculations but allows a future menu selection concerning the plotting of the data. Selection of "NN" provides a presupposed response to the next prompt and provides an early answer that logarithms are not to be used in either the calculations or the plotting of the graphical output. The selection of "EX" terminates the program.

Providing the "NN" option was not selected, the user is prompted with the prompt for the plotting relative to logarithms:

PLOT LOGS? X Y XY N NN EX

This prompt is analogous to the previous and allows selection of options associated with the plotted output.

DATA SCALING MENU:

The data scaling options menu allows the scaling of the data for plotting purposes. The form of this menu is:

SCALE DATA - ENTER S X Y O E N IN ANY ORDER

S - SCALE DATA	X - ORIGIN IS AT X=0
Y - ORIGIN IS AT Y=0	O - USER SPECIFIED ORIGIN
E - END(STOP)	N - NOTHING

Prior to plotting the data, it must be scaled to provide scaling parameters/factors to assure that all data will appear within the range of the graphical plot. The selection of the "S" option scales the data in a manner such that the range of the X and Y axes will contain all data. If the data is somewhat integer-like, data points may be located on the axes which may not provide an attractive output plot. To avoid this shortcoming of the scaling, additional scaling options are provided. The selection of "SX", "SY", or "SXY" will scale the data in a manner such that the origin is located at X=0, Y=0 or X=Y=0, respectively. This option, depending on the data, may then displace the curve from the origin. Care should be taken before using this option to assure the data can be represented adequately with its use. If negative numbers are involved, the program will prompt the user to this fact and not allow the option to be used.

While the program selects reasonable numbers for labeling the tic marks on the axes, they may be manually adjusted to the satisfaction of the user by specifying the "SO" option. If the "SO" option is selected, the program will calculate an initial set of scaling parameters and display them to the user in the form of a prompt:

ORIGIN AT X = .80000 STEPS OF .80000

ENTER NEW VALUES, OTHERWISE ENTER ,,

At this time, the user may elect to use these scaling parameters by entering ".,", or enter parameters of his choosing by specifying the value of X(or Y) at the origin and the value of the increment of X(or Y) associated with each major tic mark. It should be noted that the user must select these parameters

such that all data is contained within the resulting plot. The graphical output is such that there are eight (8) divisions along the X axis and five (5) along the Y axis. If the range of the axes is not adequate to contain the data, data points may "wrap around" and appear in strange locations or not appear in the graphical output. The program will check the values thus entered to assure the range is appropriate to contain all data. If the range is found to be inadequate, the user will be prompted in the form:

SPECIFIED ORIGIN LARGER THAN SOME DATA POINTS - RE-ENTER

At this time the user should enter a new value for the origin. If the range is still found to be inadequate, the user is further prompted by:

STEP SIZE INSUFFICIENT FOR DATA - RE-ENTER

At which time the user can adjust the increments associated with each major tic mark.

OPTION SELECTION MENU:

Initially, the program exercises the first six of the possible options automatically and provides as guidance to the user a measure of the "goodness" of the fit in terms of the coefficient of determination, RSQ, previously discussed. The following form of information is then provided the user with the prompt allowing the user to specify the option of his choice.

EQN#	FUNCTION	RSQ
1	$Y = A + BX$	.4163
2	$Y = A * E^{BX}$	.4224
3	$Y = A * X^{*B}$	.5390
4	$Y = A + B/X$	.5358
5	$Y = 1/(A+B*X)$	.4255
6	$Y = X/(A+B*X)$	.5911
7	POLYNOMIAL	
8	LAGRANGE INTERPOLATION	
9	SPLINE FIT	
10	FOURIER SERIES	
11	DATA ALONE	
12	NATURAL CUBIC SPLINE	
13	SMOOTHED DATA	

ENTER: # L SA ST DA RS PN LI RP EX

# - EQUATION NUMBER	L - LIST DATA
SA - SAVE CURVE ON FILE	ST - STOP
DA - READ NEW DATA SET	RS - RESTART
PN - NEW PEN NUMBER	LI - ALT. LINE
RP - REPLOT DATA	EX - EXIT(STOP)

At this point the user is to select the option, 1 - 13, desired or an alternative operation as indicated by the alphabetic codes.

The desired mathematical form of the function with which the data is to be analyzed is selected by the appropriate numerical value 1 - 13. For the first six options, the user is provided with some indication of the appropriateness of these function to represent the data; a high degree of "fit" is indicated by a RSQ value near unity. It is recommended that the form of the function be examined particularly for the more nonlinear options 8-13 for a

RSQ value near unity simply means the curve nearly passes through all data points. The behavior of the curve between data points or the slope of the curve at the data points may not represent the physics of the data.

Option 7, the polynomial, may be up to 14th order. If this option is selected, the user will be prompted to select the desired order. If an order is selected that is not supported by the data, i.e. larger order than there are data points, the program will correct the choice of order to a more appropriate value.

Option 8 will prompt the user to select the appropriate number of data points to be used in the polynomial interpolating formula; usually between 2 and 4. Additionally, a brief help menu is provided for this option.

Option 9 will automatically divide the data range into three subranges for fitting by third degree polynomials in each subrange.

Option 10 will also prompt the user to select the appropriate number of series terms to be used.

Option 11 does not perform any analysis of the data but simply allows the user to plot the input values.

Option 13 provides two smoothing techniques, first and third degree, and the user will be prompted to select one or the other; a brief help menu is also provided. Once the data is smoothed, the program is re-entered at the scaling menu since the data should now be somewhat more confined in terms of the excursions along the Y axis. The data is then rescaled and subsequently plotted, fitted, interpolated, or smoothed as the user desires.

The selection of the "L" option will list the data being analyzed on the screen and return to the menu for further instructions.

The "SA" option allows the user to save the data that makes up the fitted or interpolated curve. This option can only be used if a curve has been generated -that is it cannot be used on the first pass through the program. Assuming one of the eleven fitting/interpolating options has been previously selected and the resulting curve found to be worthy of saving for future use, it may be saved in a separate file by specifying the "SA" option. If this option is selected, the user will be prompted to specify a file name in which to store the data followed by a prompt as to whether the title and axes labels are to be stored also. Depending on the purpose of selecting this option, the answer may be either "Y" or "N". If, for example, the purpose of saving the data is to allow import into a different program one may not want to save the title and labels, only the X and Y values. Alternatively, if the purpose of selection of this option is to use it as input data to PCFIT the title and labels would be desired. The curves generated in any of the PCFIT programs consist of one hundred X-Y data pairs. Some programs or some situations may not allow this many data points to be used so options are provided to store 25, 50, or 100 data points. The user is prompted to enter his choice; the method used when either 50 or 25 data points is selected is to store in the file every other or every fourth data point.

The "ST" option simply terminates the program.

The selection of the "DA" option reschedules the program at the beginning allowing a new set of data to be entered. This option causes the program to discard the current data set and prompt the user for the file name of the file containing the new data to be analyzed. This option does not allow the new data to simply be appended to the end of the current data set.

The selection of the "RS" or restart option reschedules the program at the point of the LOG MENU. This option retains the data currently under analysis.

The "PN" and "LI" options are of primary use when plotting more than one curve on a single graph. These options allow different colored pens and different line types to be used. If the "PN" option is specified, the user will be prompted to enter a pen number. The specification of the "LI" option will result in a prompt allowing the user to specify an alternate line type. The default line type is a solid - the optional line types are specified by entering an integer value from 1 to 6 when prompted. Each of these options results in some form of broken or dashed line varying in the length of the dashes and spaces. See section of this chapter on plotting multiple curves for further information on the use of this option.

The "RP" or replot option reschedules the program at the point of the SCALING MENU to allow adjustments generally through the use of user specified origin option in this menu.

The "EX" option is an alternate to the "ST" option performing the same function of terminating the program.

Assuming one of the eleven function was selected as the form of the data analysis, the program calculates and displays on the monitor, and printer if not suppressed, the option selected, a measure of the quality of the fitted/interpolated curve, RSQ, and the appropriate coefficients. This information will be displayed in the form:

OPTION NO. 7

Y=POLYNOMIAL

DEGREE = 5

RSQ = .8893

C0 = .246761E+01

C1 = -.128385E+01

C2 = .125361E+01

C3 = -.470453E+00

C4 = .863621E-01

C5 = -.617910E-02

PLOTTING MENU:

Following the display of the coefficients, the user is presented with the PLOTTING MENU. This menu is for the selection of options associated with the plotting and display of the data points only. The fitted curve is always in the form of one hundred data points that in general are closely spaced to appear as a continuous curve. The plotting option menu has the form:

READY PLOTTER -- ENTER G C A F P N D E ANY ORDER

G - PLOT GRIDS

C - GRID INTERSECTION PLOTTED

A - PLOT AXES

F - DRAW FORM

P - PLOT POINTS

N - NOTHING

H - PLOT HORIZONTAL AXIS

R - PLOT RIGHT AXIS

L - PLOT LEFT AXIS

B - PLOT REVERSE AXES

D - READ ADDITIONAL DATA

E - END(STOP)

The user may enter up to ten of the letters in a string to specify the selection of options. However, there are not in general ten options to be selected at any one time.

Specification of the "G" option will result in a plotted output with grid squares; the "C" option will only mark the intersection of the horizontal and vertical bounds of the grid squares with a "+". Specification of the

"A" option will plot a horizontal and vertical axis with the vertical axis located to the left. The "F" option plots a form around the output.

In order that the input data is plotted, the "P" option must be selected. Specifying this option will cause an addition prompt menu to be displayed to allow specification of the pen, nature of plotting, and symbol to be used. This prompt menu is in the form:

ENTER: PEN NUMBER, PLOT OPTION AND SYMBOL USED - WHERE:

PEN	PLOT OPTION	SYMBOL USED
1 - BLACK	-1 - SYMBOL AT EVERY POINT	0 - SQUARE
2 - RED	-2 - SYMBOL AT EVERY 2nd POINT	1 - CIRCLE
3 - GREEN	-N - SYMBOL AT EVERY Nth POINT	2 - TRIANGLE
4 - BLUE	0 - LINE PLOT ONLY	3 - +
5 - YELLOW	1 - LINE AND SYMBOL PLOT	4 - X
6 - ORANGE	2 - LINE AND SYMBOL AT	5 - DIAMOND
	EVERY 2nd POINT	
	N - LINE AND SYMBOL AT	
	EVERY Nth POINT	

The actual colors to be used depend on the arrangement of the pens in the carrousel.

The "N" option does nothing; this option will be used in the plotting of multiple curves to be discussed later. The "H" option plots only a horizontal axis; the "R" and "L" options plot the vertical axis on either the right or left end of the horizontal axis respectively. The "B" option plots both a horizontal and vertical axis with the vertical axis located on the right of the horizontal. The "D" option re-enters the program at the INPUT DATA MENU for a new data set; current data will be discarded by specifying this option. Finally the "E" option terminates the program. The program now returns to the OPTIONS MENU for selection of alternate functions or other options available to the user. This process may be repeated indefinitely at the discretion of the user.

MULTIPLE CURVES:

The PCFIT programs are not formulated so as to allow internal "storage" of curves for summary plotting of more than one curve on a graph. However, PCFITP can be used to display multiple curves by not replacing the paper and plotting a second curve on the same sheet.

Plotting of multiple curves on a single sheet can be divided in to two different types depending on whether the values or the Y-variable are in the same general range or whether they are vastly different between the curves to be plotted. In either case, the X-variable data must be in the same general range for reasonable plots.

If the data is in the same general range, the approach is to first combine all data into a single data set to allow proper scaling, scale the data to establish the scaling parameters, discard this combined data set and enter the first data set, do not re-scale data, plot points, axes, and curve, enter second data set, do not rescale, plot points and curves-no axes this time and repeat until complete. Now in somewhat more detail - in the DATA INPUT MENU the first data set is read followed by the prompt:

ADDITIONAL DATA FILES? (Y/N)

To this prompt the response should be "Y" at which point the second set of data specified by its file name will be entered and appended to the first data set. This process is repeated until all data is entered. The LOG MENU is treated as desired. In the SCALING MENU the selection is as previously described depending on the nature of the data. The combined data is thus scaled to fit within the range of the axes. In the PLOTTING MENU the response should be "D". Specification of the "D" option re-starts the program at the INPUT DATA MENU where the first data file is specified. Proceed as before through the LOG MENU. In the SCALING MENU specify "N" since re-scaling at this point will destroy the previous scaling parameters that encompass all the data sets. In the PLOTTING MENU specify plotting the axes. The data points may also be plotted if desired as may be a curve of the fitted or interpolated data. Having now plotted the first data set, the user is ready to deal with the second data set by entering "D" in the PLOTTING MENU which then prompts the user for the file name of the second data set. Proceed as before through the LOG MENU and SCALING MENU again specifying "N" in the SCALING MENU. The appropriate function for fitting or interpolating is selected from the OPTION MENU and when presented with the PLOTTING MENU, the user may elect to plot the data points. The user should not specify any option that plots axes since this was done previously and are already on the graph. Remaining data sets are processed as data set 2.

For Y-variable data sets that do not lie in the same general range such that combining on a single axis may suppress one set so as not to allow the desired level of detail an alternate approach is suggested. The first data set is processed as one would normally handle a single data set. Without changing the paper in the plotter the program is re-run with the second

data set. The only difference will be in the PLOTTING MENU where the "R" option is specified to plot the Y-axis for this data on the right side of the graph. The X-axis was plotted in the analysis of the first data set.

V. EXAMPLES

EXAMPLE 1

Example 1 illustrates the use of PCFITM for the single data set DATA1.DAT. Logarithm options are not used for either calculations or plotting. The simple scaling option is selected and the data is fitted to a fifth order polynomial. The graphical output normally displayed on the monitor is reproduced to illustrate the degree of detail for this option.

PCFITH
PRINTED OUTPUT? (Y/N)

N
ENTER DATA FILE NAME

DATA1.DAT

TITLE
X-AXIS
Y-AXIS

1	1.0000	2.0000
2	1.2000	2.2000
3	1.4000	2.0000
4	1.6000	2.4000
5	1.8000	2.1000
6	2.0000	2.3000
7	2.2000	2.5000
8	2.4000	2.3000
9	2.6000	2.8000
10	2.8000	2.4000
11	3.0000	2.7000
12	3.2000	3.1000
13	3.4000	2.6000
14	3.6000	3.0000
15	3.8000	2.9000
16	4.0000	3.0000
17	4.2000	3.2000
18	4.4000	3.1000
19	4.6000	3.3000
20	4.8000	3.2000
21	5.0000	3.4000
22	5.2000	3.2000
23	5.4000	3.0000
24	5.6000	2.9000
25	5.8000	2.5000
26	6.0000	2.2000

ADDITIONAL DATA FILES? (Y/N)

N

NUMBER OF DATA POINTS = 26

CALCULATE WITH LOGS? X Y XY N NN EX
 X - LOG(X DATA)
 Y - LOG(Y DATA)
 XY - LOG(X DATA) AND LOG(Y DATA)
 N - DO NOT USE LOGS - MAY USE LOGS IN PLOTTING DATA
 NN - DO NOT USE LOGS EITHER AS INPUT OR PLOTTING OF DATA
 EX - STOP

N
 PLOT LOGS? X Y XY N NN EX

N
 SCALE DATA - ENTER S X Y O E N IN ANY ORDER
 S - SCALE DATA X - ORIGIN IS AT X=0
 Y - ORIGIN IS AT Y=0 O - USER SPECIFIED ORIGIN
 E - END(STOP) N - NOTHING
 S

EQN#	FUNCTION	RSQ
1	Y = A + BX	.4163
2	Y = A + E**BX	.4224
3	Y = A + X**B	.5390
4	Y = A + B/X	.5358
5	Y = 1/(A+B*X)	.4255
6	Y = X/(A+B*X)	.5911
7	POLYNOMIAL	
8	LAGRANGE INTERPOLATION	
9	SPLINE FIT	
10	FOURIER SERIES	
11	DATA ALONE	
12	NATURAL CUBIC SPLINE	
13	SMOOTHED DATA	

ENTER: # L SA ST DA RS RP EX

- EQUATION NUMBER L - LIST DATA
 SA - SAVE CURVE ON FILE ST - STOP
 DA - READ NEW DATA SET RS - RESTART
 RP - REPLOT DATA EX - EXIT(STOP)

7
 ENTER DEGREE FOR POLYNOMIAL FIT, BETWEEN 1 AND 14
 5

.000 % DATA SPACING ERROR
 OPTION NO. 7

Y=POLYNOMIAL
 DEGREE = 5
 RSQ = .8893
 C0 = .246761E+01
 C1 = -.128385E+01
 C2 = .125361E+01
 C3 = -.470453E+00
 C4 = .863621E-01
 C5 = -.617910E-02

The graph displays the relationship between Input Data (X) and Calculated Points (*). The X-axis represents Input Data, ranging from 0.80 to 6.40. The Y-axis represents the calculated value, ranging from 2.00 to 3.33. The plot shows a series of points forming a curve that rises to a peak around X=4.72 and then falls. Cross-over points are marked with '+' symbols.

X = INPUT DATA	* = CALCULATED POINT	+ = CROSSOVER POINT
0.80		
1.36		
1.92		
2.48		
3.04		
3.60		
4.16		
4.72		
5.28		
5.84		
6.40		

N

```
# - EQUATION NUMBER          L - LIST DATA
SA - SAVE CURVE ON FILE      ST - STOP
DA - READ NEW DATA SET      RS - RESTART
RP - REPLOT DATA            EX - EXIT(STOP)
EX
```

EXAMPLE 2

Example 2 illustrates the use of PCFITG again for the data set DATA1.DAT. The logarithm option is not selected for this illustration and again the simple scaling option is used. For consistency, the fifth order polynomial is selected and the resulting graphical output illustrated. At this point the sample problem illustrates the saving of this curve in a file through the selection of the "SA" option. The curve along with the title and axes labels are saved in file DATA2.DAT.

B>PCFITG
PRINTED OUTPUT? (Y/N)

N
ENTER DATA FILE NAME

DATA1.DAT

TITLE
X-AXIS
Y-AXIS

1	1.0000	2.0000
2	1.2000	2.2000
3	1.4000	2.0000
4	1.6000	2.4000
5	1.8000	2.1000
6	2.0000	2.3000
7	2.2000	2.5000
8	2.4000	2.3000
9	2.6000	2.8000
10	2.8000	2.4000
11	3.0000	2.7000
12	3.2000	3.1000
13	3.4000	2.6000
14	3.6000	3.0000
15	3.8000	2.9000
16	4.0000	3.0000
17	4.2000	3.2000
18	4.4000	3.1000
19	4.6000	3.3000
20	4.8000	3.2000
21	5.0000	3.4000
22	5.2000	3.2000
23	5.4000	3.0000
24	5.6000	2.9000
25	5.8000	2.5000
26	6.0000	2.2000

ADDITIONAL DATA FILES? (Y/N)

N

NUMBER OF DATA POINTS = 26

CALCULATE WITH LOGS? X Y XY N NN EX
 X - LOG(X DATA)
 Y - LOG(Y DATA)
 XY - LOG(X DATA) AND LOG(Y DATA)
 N - DO NOT USE LOGS - MAY USE LOGS IN PLOTTING DATA
 NN - DO NOT USE LOGS EITHER AS INPUT OR PLOTTING OF DATA
 EX - STOP

NN
 SCALE DATA - ENTER S X Y O E N IN ANY ORDER
 S - SCALE DATA X - ORIGIN IS AT X=0
 Y - ORIGIN IS AT Y=0 O - USER SPECIFIED ORIGIN
 E - END(STOP) N - NOTHING
 S

EQN#	FUNCTION	RSQ
1	$Y = A + BX$	.4163
2	$Y = A + E \cdot BX$	.4224
3	$Y = A + X \cdot B$	.5390
4	$Y = A + B/X$	.5358
5	$Y = 1/(A+B \cdot X)$	.4255
6	$Y = X/(A+B \cdot X)$	.5911
7	POLYNOMIAL	
8	LAGRANGE INTERPOLATION	
9	SPLINE FIT	
10	FOURIER SERIES	
11	DATA ALONE	
12	NATURAL CUBIC SPLINE	
13	SMOOTHED DATA	

ENTER: # L SA ST DA RS RP EX

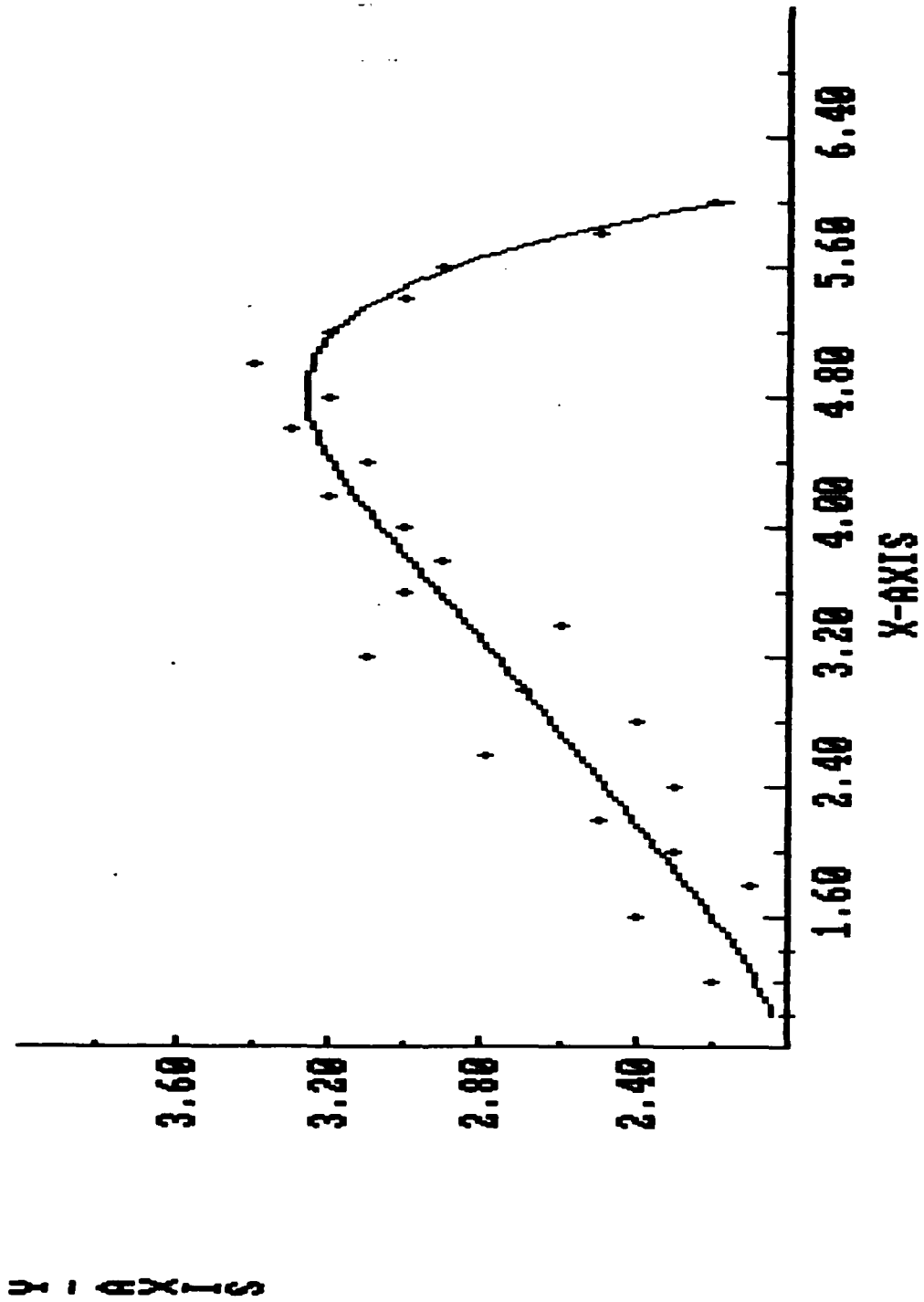
- EQUATION NUMBER L - LIST DATA
 SA - SAVE CURVE ON FILE ST - STOP
 DA - READ NEW DATA SET RS - RESTART
 RP - REPLOT DATA EX - EXIT(STOP)

7
 ENTER DEGREE FOR POLYNOMIAL FIT, BETWEEN 1 AND 14
 5

.000 % DATA SPACING ERROR
 OPTION NO. 7
 Y=POLYNOMIAL
 DEGREE = 5
 RSQ = .8893
 C0 = .246761E+01
 C1 = -.128385E+01
 C2 = .125361E+01
 C3 = -.470453E+00
 C4 = .863621E-01
 C5 = -.617910E-02

HARD COPY? (Y/N)
Y

TITLE



EQN#	FUNCTION	RSQ
1	$Y = A + BX$	.4163
2	$Y = A + E^{*}BX$	.4224
3	$Y = A + X^{*}B$	.5390
4	$Y = A + B/X$	.5358
5	$Y = 1/(A+B*X)$	.4255
6	$Y = X/(A+B*X)$	.5911
7	POLYNOMIAL	
8	LAGRANGE INTERPOLATION	
9	SPLINE FIT	
10	FOURIER SERIES	
11	DATA ALONE	
12	NATURAL CUBIC SPLINE	
13	SMOOTHED DATA	

ENTER: # L SA ST DA RS RP EX

# - EQUATION NUMBER	L - LIST DATA
SA - SAVE CURVE ON FILE	ST - STOP
DA - READ NEW DATA SET	RS - RESTART
RP - REPLOT DATA	EX - EXIT(STOP)

SA

ENTER THE FILE NAME TO BE USED

DATA2.DAT 5.DAT

SAVE TITLE AND AXES LABELS? (Y/N)

Y

TITLE

X-AXIS

Y-AXIS

SAVE 25, 50 OR 100 POINTS ON CURVE?

25

1.0000000	2.0470930
1.2020200	2.0833980
1.4040400	2.1360680
1.6060610	2.1988780
1.8080810	2.2673180
2.0101010	2.3383490
2.2121210	2.4101520
2.4141420	2.4818750
2.6161630	2.5533880
2.8181830	2.6250320
3.0202040	2.6973680
3.2222250	2.7709300
3.4242450	2.8459730
3.6262660	2.9222260
3.8282870	2.9986410
4.0303070	3.0731420
4.2323280	3.1423800
4.4343490	3.2014780
4.6363690	3.2437860
4.8383900	3.2606290
5.0404110	3.2410570
5.2424310	3.1716000
5.4444520	3.0360110
5.6464720	2.8150240
5.8484930	2.4860990

3.2222250	2.7709300
3.4242450	2.8459730
3.6262660	2.9222260
3.8282870	2.9986410
4.0303070	3.0731420
4.2323280	3.1423800
4.4343490	3.2014780
4.6363690	3.2437860
4.8383900	3.2606290
5.0404110	3.2410570
5.2424310	3.1716000
5.4444520	3.0360110
5.6464720	2.8150240
5.8484930	2.4860990

ENTER: # L SA ST DA RS RP EX

# - EQUATION NUMBER	L - LIST DATA
SA - SAVE CURVE ON FILE	ST - STOP
DA - READ NEW DATA SET	RS - RESTART
RP - REPLOT DATA	EX - EXIT(STOP)
EX	

Stop - Program terminated.

EXAMPLE 3

Example 3 illustrates the use of PCFITP for data set DATA1.DAT. As in the previous sample problems no logarithms are used, however, the optional scaling technique of defining the origin at 0,0 is selected. Again the fifth order polynomial is selected. For plotting of the data, the options "PAF" are selected which a. plot the data points, b. plot axes, and c. draw a form around the resulting plot. The user is prompted to select options relative to how the data is to be plotted. The option "1,-1,0" is used to use the black pen, plot individual data points and use the square as a symbol to represent the data.

The example then illustrates plotting additional curves resulting from selection of options 2 and 4 on the same graphical output.

PCFITP
PRINTED OUTPUT? (Y/N)

N
ENTER DATA FILE NAME

DATA1.DAT

TITLE

X-AXIS

Y-AXIS

1.0000	2.0000
1.2000	2.2000
1.4000	2.0000
1.6000	2.4000
1.8000	2.1000
2.0000	2.3000
2.2000	2.5000
2.4000	2.3000
2.6000	2.8000
2.8000	2.4000
3.0000	2.7000
3.2000	3.1000
3.4000	2.6000
3.6000	3.0000
3.8000	2.9000
4.0000	3.0000
4.2000	3.2000
4.4000	3.1000
4.6000	3.3000
4.8000	3.2000
5.0000	3.4000
5.2000	3.2000
5.4000	3.0000
5.6000	2.9000
5.8000	2.5000
6.0000	2.2000

ADDITIONAL DATA FILES? (Y/N)

N

NUMBER OF DATA POINTS 26
CALCULATE WITH LOGS? X Y XY N NN EX

X - LOG(X DATA)

Y - LOG(Y DATA)

XY - LOG(X DATA) AND LOG(Y DATA)

N - DO NOT USE LOGS - MAY USE LOGS IN PLOTTING DATA

NN - DO NOT USE LOGS EITHER AS INPUT OR PLOTTING OF DATA

EX - STOP

NN

SCALE DATA - ENTER S X Y-O E N IN ANY ORDER

S - SCALE DATA X - ORIGIN IS AT X=0
Y - ORIGIN IS AT Y=0 O - USER SPECIFIED ORIGIN
E - END(STOP) N - NOTHING

~vY
EQN# FUNCTION RSQ
1 Y = A + BX .4163
2 Y = A * E**BX .4224
3 Y = A * X**B .5390
4 Y = A + B/X .5358
5 Y = 1/(A+B*X) .4255
6 Y = X/(A+B*X) .5911
7 POLYNOMIAL
8 LAGRANGE INTERPOLATION
9 SPLINE FIT
10 FOURIER SERIES
11 Y DATA ALONE
12 NATURAL CUBIC SPLINE
13 SMOOTHED DATA

ENTER: # L SA ST DA RS PN LI RP EX

- EQUATION NUMBER L - LIST DATA
SA - SAVE CURVE IN FILE ST - STOP
DA - READ NEW DATA RS - RESTART
PN - NEW PEN NUMBER LI - ALT. LINE
RP - REPLOT DATA EX - END(STOP)

7

ENTER DEGREE FOR POLYNOMIAL FIT, BETWEEN 1 AND 14

5

.000 % DATA SPACING ERROR

OPTION NO. 7

Y=POLYNOMIAL

DEGREE = 5

RSQ = .8893

C0 = .246761E+01

C1 = -.128385E+01

C2 = .125361E+01

C3 = -.470453E+00

C4 = .863621E-01

C5 = -.617910E-02

READY PLOTTER -- ENTER G C A F P N D E ANY ORDER

G - PLOT GRID	C - GRID INTERSECTIONS PLOTTED
A - PLOT AXIS	F - DRAW FORM
P - PLOT POINTS	N - NOTHING
H - PLOT HORIZONTAL AXIS	R - PLOT RIGHT AXIS
L - PLOT LEFT AXIS	B - PLOT REVERSE AXIS
D - READ ADDITIONAL DATA	E - END (STOP)

PAF

ENTER: PEN NUMBER, PLOT OPTION AND SYMBOL USED - WHERE:

PEN	PLOT OPTION	SYMBOL USED
1 - BLACK	-1 - SYMBOL AT EVERY POINT	0 - SQUARE
2 - RED	-2 - SYMBOL AT EVERY 2nd POINT	1 - CIRCLE
3 - GREEN	-N - SYMBOL AT EVERY Nth POINT	2 - TRIANGLE
4 - BLUE	0 - LINE PLOT ONLY	3 - +
5 - BLACK	1 - LINE AND SYMBOL PLOT	4 - X
6 - RED	2 - LINE AND SYMBOL AT EVERY 2nd POINT	5 - DIAMOND
	N - LINE AND SYMBOL AT EVERY Nth POINT	

1,-1,0

ENTER: # L SA ST DA RS PN LI RP EX

# - EQUATION NUMBER	L - LIST DATA
SA - SAVE CURVE IN FILE	ST - STOP
DA - READ NEW DATA	RS - RESTART
PN - NEW PEN NUMBER	LI - ALT. LINE
RP - REPLOT DATA	EX - END(STOP)

LI

ENTER LINE STYLE CODE

2

ENTER: # L SA ST DA RS PN LI RP EX

# - EQUATION NUMBER	L - LIST DATA
SA - SAVE CURVE IN FILE	ST - STOP
DA - READ NEW DATA	RS - RESTART
PN - NEW PEN NUMBER	LI - ALT. LINE
RP - REPLOT DATA	EX - END(STOP)

4

OPTION NO. 4

RSQ = .5358

$Y = A + B \cdot X$

A = .323702E+01

B = -.145030E+01

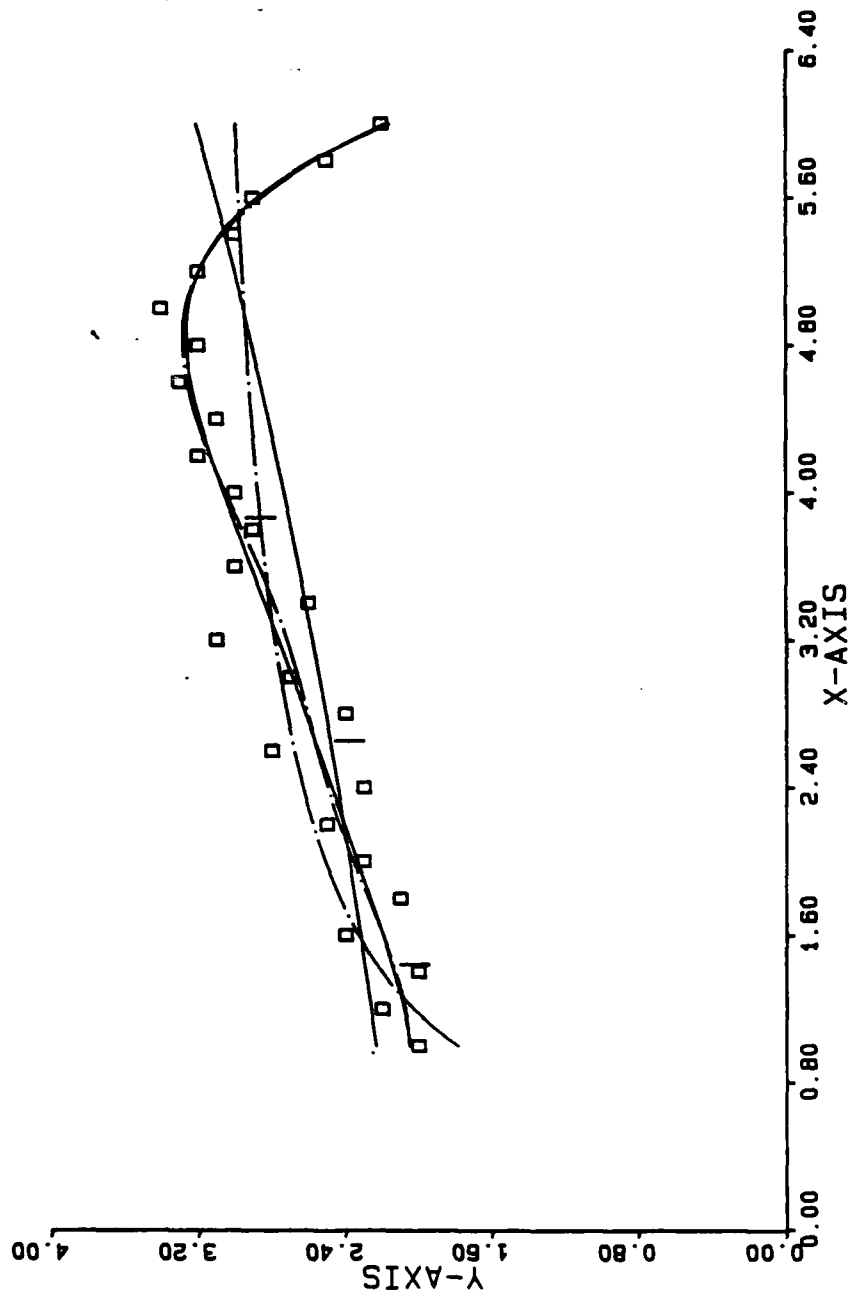
ENTER: # L SA ST DA RS PN LI RP EX

# - EQUATION NUMBER	L - LIST DATA
SA - SAVE CURVE IN FILE	ST - STOP
DA - READ NEW DATA	RS - RESTART
PN - NEW PEN NUMBER	LI - ALT. LINE
RP - REPLOT DATA	EX - END(STOP)

EX

Stop - Program terminated.

TITLE



EXAMPLE 4

Example 4 illustrates the handling of two different data sets the first is DATA1.DAT, and the second is a data set with larger Y values to illustrate scaling of the combined data. The second data set is combined with the first by specifying "Y" to the prompt relative to additional data files. The logarithm options are not used and the combined data sets are scaled using the "SXY" option as in Example 3.

At this point the combined data is discarded and the first data set, DATA1.DAT, is processed taking care not to rescale the data. The second data set is then processed accordingly.

PRINTED OUTPUT? (Y/N)

N

ENTER DATA FILE NAME

DATA1.DAT

TITLE

X-AXIS

Y-AXIS

1.0000	2.0000
1.2000	2.2000
1.4000	2.0000
1.6000	2.4000
1.8000	2.1000
2.0000	2.3000
2.2000	2.5000
2.4000	2.3000
2.6000	2.8000
2.8000	2.4000
3.0000	2.7000
3.2000	3.1000
3.4000	2.6000
3.6000	3.0000
3.8000	2.9000
4.0000	3.0000
4.2000	3.2000
4.4000	3.1000
4.6000	3.3000
4.8000	3.2000
5.0000	3.4000
5.2000	3.2000
5.4000	3.0000
5.6000	2.9000
5.8000	2.5000
6.0000	2.2000

ADDITIONAL DATA FILES? (Y/N)

Y

ENTER DATA FILE NAME

DATA2.DAT

TITLE

X-AXIS

Y-AXIS

.5000	2.0000
1.0000	3.0000
1.5000	4.0000
2.0000	5.0000
2.5000	4.0000
3.0000	3.0000
3.5000	2.0000

ADDITIONAL DATA FILES? (Y/N)

N

NUMBER OF DATA POINTS - 33
 CALCULATE WITH LOGS? X Y XY N NN EX
 X - LOG(X DATA)
 Y - LOG(Y DATA)
 XY - LOG(X DATA) AND LOG(Y DATA)
 N - DO NOT USE LOGS - MAY USE LOGS IN PLOTTING DATA
 NN - DO NOT USE LOGS EITHER AS INPUT OR PLOTTING OF DATA
 EX - STOP

NN

SCALE DATA - ENTER S X Y O E N IN ANY ORDER

S - SCALE DATA X - ORIGIN IS AT X=0
 Y - ORIGIN IS AT Y=0 O - USER SPECIFIED ORIGIN
 E - END(STOP) N - NOTHING

SXY

EQN#	FUNCTION	RSQ
1	$Y = A + BX$	.0319
2	$Y = A * E^{BX}$	.0648
3	$Y = A * X^{*B}$	.1079
4	$Y = A + B/X$	.0861
5	$Y = 1/(A+B*X)$	.1009
6	$Y = X/(A+B*X)$	.1781
7	POLYNOMIAL	
8	LAGRANGE INTERPOLATION	
9	SPLINE FIT	
10	FOURIER SERIES	
11	Y DATA ALONE	
12	NATURAL CUBIC SPLINE	
13	SMOOTHED DATA	

ENTER: # L SA ST DA RS PN LI RP EX

# - EQUATION NUMBER	L - LIST DATA
SA - SAVE CURVE IN FILE	ST - STOP
DA - READ NEW DATA	RS - RESTART
PN - NEW PEN NUMBER	LI - ALT. LINE
RP - REPLOT DATA	EX - END(STOP)

DA

ENTER DATA FILE NAME

DATA1.DAT

TITLE

X-AXIS

Y-AXIS

1.0000	2.0000
1.2000	2.2000
1.4000	2.0000
1.6000	2.4000
1.8000	2.1000
2.0000	2.3000
2.2000	2.5000
2.4000	2.3000
2.6000	2.8000
2.8000	2.4000

3.0000	2.7000
3.2000	3.1000
3.4000	2.6000
3.6000	3.0000
3.8000	2.9000
4.0000	3.0000
4.2000	3.2000
4.4000	3.1000
4.6000	3.3000
4.8000	3.2000
5.0000	3.4000
5.2000	3.2000
5.4000	3.0000
5.6000	2.9000
5.8000	2.5000
6.0000	2.2000

ADDITIONAL DATA FILES? (Y/N)

N

NUMBER OF DATA POINTS 26

CALCULATE WITH LOGS? X Y XY N NN EX

X - LOG(X DATA)

Y - LOG(Y DATA)

XY - LOG(X DATA) AND LOG(Y DATA)

N - DO NOT USE LOGS - MAY USE LOGS IN PLOTTING DATA

NN - DO NOT USE LOGS EITHER AS INPUT OR PLOTTING OF DATA

EX - STOP

NN

SCALE DATA - ENTER S X Y O E N IN ANY ORDER

S - SCALE DATA -X - ORIGIN IS AT X=0
 Y - ORIGIN IS AT Y=0 O - USER SPECIFIED ORIGIN
 E - END(STOP) N - NOTHING

N

EQN#	FUNCTION	RSQ
1	$Y = A + BX$	.4163
2	$Y = A * E**BX$	.4224
3	$Y = A * X**B$	.5390
4	$Y = A + B/X$	.5358
5	$Y = 1/(A+B*X)$	.4255
6	$Y = X/(A+B*X)$	.5911
7	POLYNOMIAL	
8	LAGRANGE INTERPOLATION	
9	SPLINE FIT	
10	FOURIER SERIES	
11	Y DATA ALONE	
12	NATURAL CUBIC SPLINE	
13	SMOOTHED DATA	

ENTER: # L SA ST DA RS PN LI RP EX

# - EQUATION NUMBER	L - LIST DATA
SA - SAVE CURVE IN FILE	ST - STOP
DA - READ NEW DATA	RS - RESTART

PN - NEW PEN NUMBER	LI - ALT. LINE
RP - REPLOT DATA	EX - END(STOP)

7

ENTER DEGREE FOR POLYNOMIAL FIT, BETWEEN 1 AND 14

5

.000 % DATA SPACING ERROR

OPTION NO. 7

Y=POLYNOMIAL

DEGREE = 5

RSQ = .8893

C0 = .246761E+01

C1 = -.128385E+01

C2 = .125361E+01

C3 = -.470453E+00

C4 = .863621E-01

C5 = -.617910E-02

READY PLOTTER -- ENTER G C A F P N D E ANY ORDER

G - PLOT GRID	C - GRID INTERSECTIONS PLOTTED
A - PLOT AXIS	F - DRAW FORM
P - PLOT POINTS	N - NOTHING
H - PLOT HORIZONTAL AXIS	R - PLOT RIGHT AXIS
L - PLOT LEFT AXIS	B - PLOT REVERSE AXIS
D - READ ADDITIONAL DATA	E - END(STOP)

PAF

ENTER: PEN NUMBER, PLOT OPTION AND SYMBOL USED - WHERE:

PEN	PLOT OPTION	SYMBOL USED
1 - BLACK	-1 - SYMBOL AT EVERY POINT	0 - SQUARE
2 - RED	-2 - SYMBOL AT EVERY 2nd POINT	1 - CIRCLE
3 - GREEN	-N - SYMBOL AT EVERY Nth POINT	2 - TRIANGLE
4 - BLUE	0 - LINE PLOT ONLY	3 - +
5 - BLACK	1 - LINE AND SYMBOL PLOT	4 - X
6 - RED	2 - LINE AND SYMBOL AT EVERY 2nd POINT	5 - DIAMOND
	N - LINE AND SYMBOL AT EVERY Nth POINT	

1,-1,0

ENTER: # L SA ST DA RS PN LI RP EX

# - EQUATION NUMBER	L - LIST DATA
SA - SAVE CURVE IN FILE	ST - STOP
DA - READ NEW DATA	RS - RESTART
PN - NEW PEN NUMBER	LI - ALT. LINE
RP - REPLOT DATA	EX - END(STOP)

DA

ENTER DATA FILE NAME

DATA2.DAT

TITLE

X-AXIS

Y-AXIS

.5000	2.0000
1.0000	3.0000
1.5000	4.0000
2.0000	5.0000
2.5000	4.0000
3.0000	3.0000
3.5000	2.0000

ADDITIONAL DATA FILES? (Y/N)

N

NUMBER OF DATA POINTS 7
 CALCULATE WITH LOGS? X Y XY N NN EX
 X - LOG(X DATA)
 Y - LOG(Y DATA)
 XY - LOG(X DATA) AND LOG(Y DATA)
 N - DO NOT USE LOGS - MAY USE LOGS IN PLOTTING DATA
 NN - DO NOT USE LOGS EITHER AS INPUT OR PLOTTING OF DATA
 EX - STOP

NN

SCALE DATA - ENTER S X Y O E N IN ANY ORDER

S - SCALE DATA X - ORIGIN IS AT X=0
 Y - ORIGIN IS AT Y=0 O - USER SPECIFIED ORIGIN
 E - END(STOP) N - NOTHING

N

EQN#	FUNCTION	RSQ
1	Y = A + BX	.0000
2	Y = A * E**BX	.0000
3	Y = A * X**B	.0629
4	Y = A + B/X	.1765
5	Y = 1/(A+B*X)	.0000
6	Y = X/(A+B*X)	.2098
7	POLYNOMIAL	
8	LAGRANGE INTERPOLATION	
9	SPLINE FIT	
10	FOURIER SERIES	
11	Y DATA ALONE	
12	NATURAL CUBIC SPLINE	
13	SMOOTHED DATA	

ENTER: # L SA ST DA RS PN LI RP EX

# - EQUATION NUMBER	L - LIST DATA
SA - SAVE CURVE IN FILE	ST - STOP
DA - READ NEW DATA	RS - RESTART
PN - NEW PEN NUMBER	LI - ALT. LINE
RP - REPLOT DATA	EX - END(STOP)

LI
 ENTER LINE STYLE CODE
 2

ENTER: # L SA ST DA RS PN LI RP EX

# - EQUATION NUMBER	L - LIST DATA
SA - SAVE CURVE IN FILE	ST - STOP
DA - READ NEW DATA	RS - RESTART
PN - NEW PEN NUMBER	LI - ALT. LINE
RP - REPLOT DATA	EX - END(STOP)

7

ENTER DEGREE FOR POLYNOMIAL FIT, BETWEEN 1 AND 14

4

.000 % DATA SPACING ERROR

OPTION NO. 7

Y=POLYNOMIAL

DEGREE = 4

RSQ = .9760

C0 = .328571E+01

C1 = -.630303E+01

C2 = .933333E+01

C3 = -.387879E+01

C4 = .484848E+00

READY PLOTTER -- ENTER G C A F P N D E ANY ORDER

G - PLOT GRID	C - GRID INTERSECTIONS PLOTTED
A - PLOT AXIS	F - DRAW FORM
P - PLOT POINTS	N - NOTHING
H - PLOT HORIZONTAL AXIS	R - PLOT RIGHT AXIS
L - PLOT LEFT AXIS	B - PLOT REVERSE AXIS
D - READ ADDITIONAL DATA	E - END(STOP)

P

ENTER: PEN NUMBER, PLOT OPTION AND SYMBOL USED - WHERE:

PEN	PLOT OPTION	SYMBOL USED
-----	-------------	-------------

1 - BLACK	-1 - SYMBOL AT EVERY POINT	0 - SQUARE
2 - RED	-2 - SYMBOL AT EVERY 2nd POINT	1 - CIRCLE
3 - GREEN	-N - SYMBOL AT EVERY Nth POINT	2 - TRIANGLE
4 - BLUE	0 - LINE PLOT ONLY	3 - +
5 - BLACK	1 - LINE AND SYMBOL PLOT	4 - X
6 - RED	2 - LINE AND SYMBOL AT EVERY 2nd POINT	5 - DIAMOND
	N - LINE AND SYMBOL AT EVERY Nth POINT	

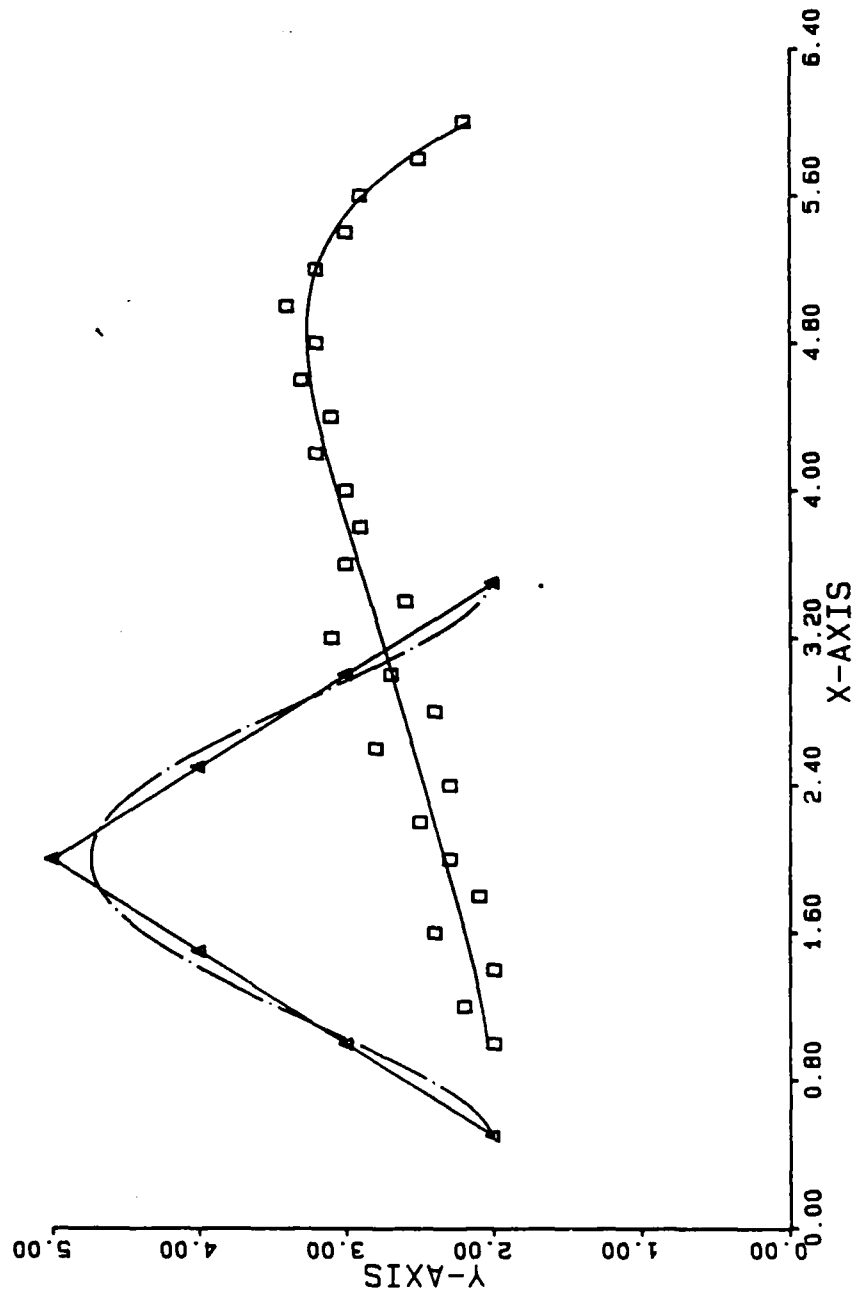
1,1,2

ENTER: # L SA ST DA RS PN LI RP EX

# - EQUATION NUMBER	L - LIST DATA
SA - SAVE CURVE IN FILE	ST - STOP
DA - READ NEW DATA	RS - RESTART
PN - NEW PEN NUMBER	LI - ALT. LINE
RP - REPLOT DATA	EX - END(STOP)

EX
Stop - Program terminated.

TITLE



EXAMPLE 5

Example 5 illustrates the processing of two different data sets that differ significantly in range such that to combine the data sets for scaling would suppress one in an undesirable fashion. The first data set is processed as in Example 3 followed by the processing of the second data set. Note in particular the manner in which the plotting options are selected.

PRINTED OUTPUT? (Y/N)

N

ENTER DATA FILE NAME

DABA1.DAT

TITLE

X-AXIS

Y-AXIS

1.0000	2.0000
1.2000	2.2000
1.4000	2.0000
1.6000	2.4000
1.8000	2.1000
2.0000	2.3000
2.2000	2.5000
2.4000	2.3000
2.6000	2.8000
2.8000	2.4000
3.0000	2.7000
3.2000	3.1000
3.4000	2.6000
3.6000	3.0000
3.8000	2.9000
4.0000	3.0000
4.2000	3.2000
4.4000	3.1000
4.6000	3.3000
4.8000	3.2000
5.0000	3.4000
5.2000	3.2000
5.4000	3.0000
5.6000	2.9000
5.8000	2.5000
6.0000	2.2000

ADDITIONAL DATA FILES? (Y/N)

N

NUMBER OF DATA POINTS 26

CALCULATE WITH LOGS? X Y XY N NN EX

X - LOG(X DATA)

Y - LOG(Y DATA)

XY - LOG(X DATA) AND LOG(Y DATA)

N - DO NOT USE LOGS - MAY USE LOGS IN PLOTTING DATA

NN - DO NOT USE LOGS EITHER AS INPUT OR PLOTTING OF DATA

EX - STOP

NN

SCALE DATA - ENTER S X Y O E N IN ANY ORDER

S - SCALE DATA X - ORIGIN IS AT X=0
Y - ORIGIN IS AT Y=0 O - USER SPECIFIED ORIGIN
E - END(STOP) N - NOTHING

SVV

EQN#	FUNCTION	RSQ
1	$Y = A + BX$	.4163
2	$Y = A * E^{BX}$	.4224
3	$Y = A * X^B$	.5390
4	$Y = A + B/X$	.5358
5	$Y = 1/(A+BX)$	.4255
6	$Y = X/(A+BX)$	.5911
7	POLYNOMIAL	
8	LAGRANGE INTERPOLATION	
9	SPLINE FIT	
10	FOURIER SERIES	
11	Y DATA ALONE	
12	NATURAL CUBIC SPLINE	
13	SMOOTHED DATA	

ENTER: # L SA ST DA RS PN LI RP EX

# - EQUATION NUMBER	L - LIST DATA
SA - SAVE CURVE IN FILE	ST - STOP
DA - READ NEW DATA	RS - RESTART
PN - NEW PEN NUMBER	LI - ALT. LINE
RP - REPLOT DATA	EX - END(STOP)

7

ENTER DEGREE FOR POLYNOMIAL FIT, BETWEEN 1 AND 14

5

.000 % DATA SPACING ERROR

OPTION NO. 7

Y=POLYNOMIAL

DEGREE = 5

RSQ = .8893

C0 = .246761E+01

C1 = -.128385E+01

C2 = .125361E+01

C3 = -.470453E+00

C4 = .863621E-01

C5 = -.617910E-02

READY PLOTTER -- ENTER G C A F P N D E ANY ORDER

G - PLOT GRID	C - GRID INTERSECTIONS PLOTTED
A - PLOT AXIS	F - DRAW FORM
P - PLOT POINTS	N - NOTHING
H - PLOT HORIZONTAL AXIS	R - PLOT RIGHT AXIS
L - PLOT LEFT AXIS	B - PLOT REVERSE AXIS
D - READ ADDITIONAL DATA	E - END(STOP)

PAF

ENTER: PEN NUMBER, PLOT OPTION AND SYMBOL USED - WHERE:

PEN	PLOT OPTION	SYMBOL USED
1 - BLACK	-1 - SYMBOL AT EVERY POINT	0 - SQUARE
2 - RED	-2 - SYMBOL AT EVERY 2nd POINT	1 - CIRCLE
3 - GREEN	-N - SYMBOL AT EVERY Nth POINT	2 - TRIANGLE
4 - BLUE	0 - LINE PLOT ONLY	3 - +
5 - BLACK	1 - LINE AND SYMBOL PLOT	4 - X
6 - RED	2 - LINE AND SYMBOL AT EVERY 2nd POINT	5 - DIAMOND
	N - LINE AND SYMBOL AT EVERY Nth POINT	

1,-1,0

ENTER: # L SA ST DA RS PN LI RP EX

# - EQUATION NUMBER	L - LIST DATA
SA - SAVE CURVE IN FILE	ST - STOP
DA - READ NEW DATA	RS - RESTART
PN - NEW PEN NUMBER	LI - ALT. LINE
RP - REPLOT DATA	EX - END(STOP)

DA

ENTER DATA FILE NAME

DATA3.DAT

TITLE

X-AXIS

Y-AXIS

.5000	20.0000
1.0000	30.0000
1.5000	40.0000
2.0000	50.0000
2.5000	40.0000
3.0000	30.0000
3.5000	20.0000

ADDITIONAL DATA FILES? (Y/N)

N

NUMBER OF DATA POINTS 7

CALCULATE WITH LOGS? X Y XY N NN EX

X - LOG(X DATA)

Y - LOG(Y DATA)

XY - LOG(X DATA) AND LOG(Y DATA)

N - DO NOT USE LOGS - MAY USE LOGS IN PLOTTING DATA

NN - DO NOT USE LOGS EITHER AS INPUT OR PLOTTING OF DATA

EX - STOP

NN

SCALE DATA - ENTER S X Y O E N IN ANY ORDER

S - SCALE DATA

X - ORIGIN IS AT X=0

Y - ORIGIN IS AT Y=0

O - USER SPECIFIED ORIGIN

E - END(STOP)

N - NOTHING

SXY

EQN#	FUNCTION	RSQ
1	$Y = A + BX$	.0000
2	$Y = A * E^{BX}$	.0000
3	$Y = A * X^{*B}$	.0629
4	$Y = A + B/X$	.1765
5	$Y = 1/(A+BX)$	.0000
6	$Y = X/(A+BX)$	.2098
7	POLYNOMIAL	
8	LAGRANGE INTERPOLATION	
9	SPLINE FIT	
10	FOURIER SERIES	
11	Y DATA ALONE	
12	NATURAL CUBIC SPLINE	
13	SMOOTHED DATA	

ENTER: # L SA ST DA RS PN LI RP EX

# - EQUATION NUMBER	L - LIST DATA
SA - SAVE CURVE IN FILE	ST - STOP
DA - READ NEW DATA	RS - RESTART
PN - NEW PEN NUMBER	LI - ALT. LINE
RP - REPLOT DATA	EX - END(STOP)

LI
ENTER LINE STYLE CODE
2

ENTER: # L SA ST DA RS PN LI RP EX

# - EQUATION NUMBER	L - LIST DATA
SA - SAVE CURVE IN FILE	ST - STOP
DA - READ NEW DATA	RS - RESTART
PN - NEW PEN NUMBER	LI - ALT. LINE
RP - REPLOT DATA	EX - END(STOP)

7
ENTER DEGREE FOR POLYNOMIAL FIT, BETWEEN 1 AND 14
4

.000 % DATA SPACING ERROR
OPTION NO. 7
Y=POLYNOMIAL
DEGREE = 4
RSQ = .9760
C0 = .328571E+02
C1 = -.630303E+02
C2 = .933333E+02
C3 = -.387879E+02
C4 = .484848E+01

READY PLOTTER -- ENTER G C A F P N D E ANY ORDER

G - PLOT GRID	C - GRID INTERSECTIONS PLOTTED
A - PLOT AXIS	F - DRAW FORM
P - PLOT POINTS	N - NOTHING
H - PLOT HORIZONTAL AXIS	R - PLOT RIGHT AXIS
L - PLOT LEFT AXIS	B - PLOT REVERSE AXIS
D - READ ADDITIONAL DATA	E - END(STOP)

PR

ENTER: PEN NUMBER, PLOT OPTION AND SYMBOL USED - WHERE:

PEN	PLOT OPTION	SYMBOL USED
1 - BLACK	-1 - SYMBOL AT EVERY POINT	0 - SQUARE
2 - RED	-2 - SYMBOL AT EVERY 2nd POINT	1 - CIRCLE
3 - GREEN	-N - SYMBOL AT EVERY Nth POINT	2 - TRIANGLE
4 - BLUE	0 - LINE PLOT ONLY	3 - +
5 - BLACK	1 - LINE AND SYMBOL PLOT	4 - X
6 - RED	2 - LINE AND SYMBOL AT EVERY 2nd POINT	5 - DIAMOND
	N - LINE AND SYMBOL AT EVERY Nth POINT	

1,-1,2

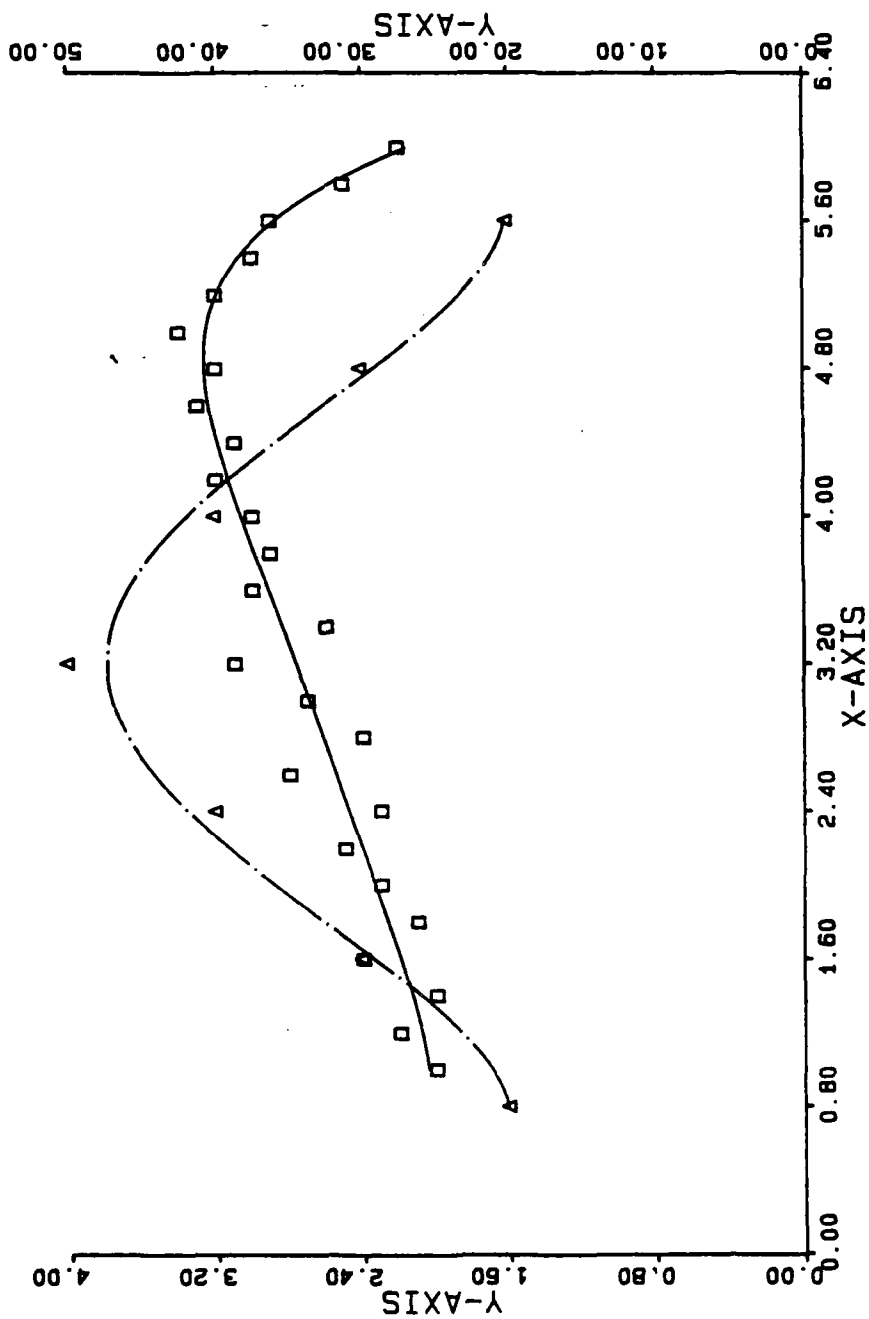
ENTER: # L SA ST DA RS PN LI RP EX

# - EQUATION NUMBER	L - LIST DATA
SA - SAVE CURVE IN FILE	ST - STOP
DA - READ NEW DATA	RS - RESTART
PN - NEW PEN NUMBER	LI - ALT. LINE
RP - REPLOT DATA	EX - END(STOP)

EX

Stop - Program terminated.

TITLE



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END
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